POWER and THE ENGINEER

EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

Vol. 32. NEW YORK, JANUARY 18, 1910 No. 3

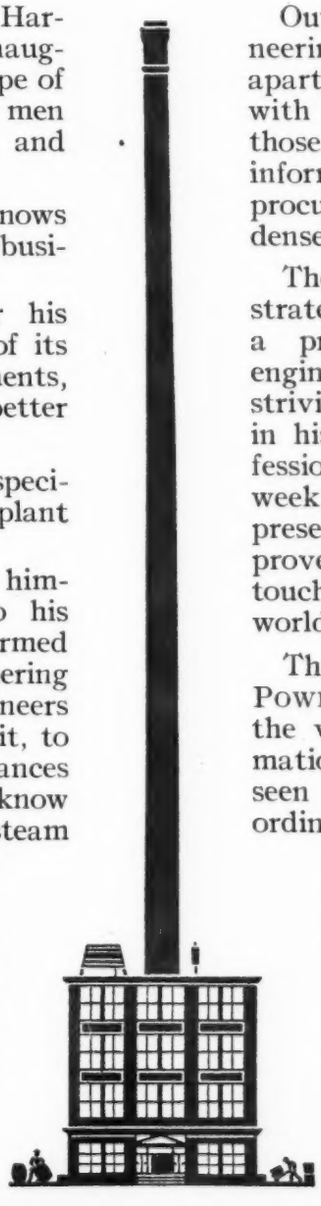
PRESIDENT LOWELL, of Harvard University, said in his inaugural address that the best type of liberal education aims to produce men who know a little of everything and *something well.*

However much an engineer knows of other things he should know his business well.

He has chosen engineering for his vocation and the more he knows of its principles, its material, its achievements, its possibilities, the bigger and the better engineer he will be.

His present and pressing duty, especially to his employer, is to keep his plant running.

Another duty which he owes to himself in a greater degree than to his employer is to keep himself informed upon what is passing in the engineering world, to know what other engineers are doing and how they are doing it, to know what new apparatus and appliances are being brought out for his use, to know the progress which is being made in steam turbines, gas engines and other lines, to benefit by the work of other engineers who are putting in new plants with all the advantages of present knowledge and available apparatus, to keep in touch with the leaders of the profession through papers presented and discussed by them before societies, and by their contributions to the literature of the subject.



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The success of POWER has demonstrated that there is a demand for such a presentation. Thirty-odd thousand engineers, from the simple attendant, striving to learn more of the machinery in his charge, to the designer and professional adviser, follow its columns each week, and find in them solutions of present difficulties, suggestions for improvement and a means of keeping in touch with what is going on in their world.

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No man can grow very great upon his own thoughts and experiences. POWER will tell you what others are thinking and doing. We can put it before you, but you must make it yours by reading.

Kansas City Boiler Explosion

Stop Valve between Boiler and Safety Valve Probable Cause of Explosion Resulting in the Death of Four Men, the Serious Injury of Two and a Property Loss of $50,000

BY EDWARD H. LANE

One of the most disastrous boiler explosions that has ever happened in this city occurred at 11 o'clock on the morning of December 6. As a result two men were instantly killed and four others were seriously injured; two of them have since died.

The building was owned by the Homestead Realty Company, and had been vacant for several months. It was being remodeled by a construction company so that the floors could be rented separately, the building being a six-story structure. The only tenant at the time of the explosion was the H. K. Mumford Drug Company, who were on the third floor, their loss being estimated at $40,000.

The floors of the first and second stories directly over the boiler collapsed when the explosion tore away their supports. The north wall of the building near the boiler was blown out of line about 6 inches and the building has been condemned, but at present repairs are being made to the first and second floors and the elevator shaft straightened up, so that the building will not be a total loss.

FIG. 1. SECOND FLOOR RESTING ON FRONT HEAD OF BOILER

The men injured and killed were a steamfitter, working on the boiler (killed), two plumbers, working near the boiler, and a negro porter who evidently was firing the boiler, as they had no engineer.

The boiler was 54 inches in diameter and 16 feet long. The shell consisted of two lengths of plate, 8 feet long, made of 5/16-inch Illinois Steel Company's flange steel. The heads were 7/16 inch thick, and the tensile strength of the metal was designated as 60,000 pounds per square inch. The boiler had thirty-six 4-inch tubes, with a manhole below the tubes at the front end and one above the tubes at the rear end. It had a dome 27 inches in diameter by 30 inches high, with a spherical top, and a 7-inch flange was riveted to the dome. The heads were braced by two 1½-inch through braces, and the segments above the tubes were stayed by four ½x3-inch flat braces extending from the shell to the head. The rivets were ¾ inch in 13/16-inch holes. The horizontal lap seams were double riveted on a 3-inch pitch, and were located above the water line.

The boiler was built by the Kewanee Boiler Company and installed about August, 1903. It was tested at the time to 150 pounds pressure and was built for 100 pounds pressure, but was used only as a heating boiler at this building, for which purpose it was supposed to carry 7 pounds pressure. The safety valve was of the lever type, 3½ inches in diameter, and the grates measured 4½x4½ feet.

Fig. 1 shows the second floor resting on the front head of the boiler, this view being taken from the first floor. About the only thing this view shows is that the brick arches over the fire doors had long ago ceased to exist, thus allowing the boiler shell forming the smoke box to become badly burned.

Fig. 2 shows how the rupture occurred, the break evidently starting directly over the fire, extending back through the first sheet to the girth seam. Then on one side the rupture started up the girth seam, but on the other side it went through the seam and took an upward turn, extending about half way through the second sheet and stopping about half way up the side of the boiler. It may be seen from this view that the flange on the tube sheet is turned down,

FIG. 2. SHOWING RUPTURE OF PLATE

some of the rivets having given way, and in other cases the holes were torn out through the plate.

The two round through braces are clearly shown in Fig. 2, and as apparent in the same view, there was not much scale on the tubes or shell. There was no mud in the boiler that could be seen, but this is usually the case with heating boilers, as they generally operate on the closed circuit system; that is, the condensate from the radiators is usually returned through the blowoff pipe, with a check valve in the return line just at the blowoff pipe to prevent water backing up into the radiators. The blowoff pipe in this boiler was 3 inches in diameter, so that it is probable that this system of piping was used. In fact, in these heating boilers, the trouble is usually not with scale or mud, but rather from erosion or pitting of the plates due to too much distilled water.

Fig. 2 shows a part of one of the horizontal seams. These horizontal seams will probably figure out to 70 per cent. efficiency, so that it would appear that the joint should have given way instead of the solid sheet.

A curious feature of the explosion was the position taken by the boiler. Originally it faced the west; Fig. 2 was taken from the southeast, showing that the boiler evidently went up front end first and then turned about half way around, finally resting on the rear end and standing nearly vertical.

Fig. 3 shows the dome and the nipple screwed into it. The wall shown is the north wall of the building and is about 6 inches out of line at the point where the boiler was set.

A good many theories have been expressed as to why the boiler exploded. One is that, on account of the day being so cold and as there were some men working in the building at the time, a fire was started in the furnace at their request. After firing for a time the negro porter probably discovered he had no water in the boiler and most likely started to feed a cold supply. Those who advance this idea point to the burned condition of the plates to prove it. Yet, considering the amount of damage, it is hard to believe that the small quantity of water that could have been fed into the boiler in such a short time, could have produced such a disturbance.

Another man who examined the boiler said that the shell simply gave way, owing to the fact that there was no water in the boiler at the time, and the metal becoming red hot the pressure was more than it could stand, especially as the sheet was thin as paper where it parted.

This appears to be a plausible theory with two exceptions: First, if there was no water in the boiler the damage surely would not have been so great. Second, although the edge of the sheet felt thin,

FIG. 3. RUPTURE AT GIRTH SEAM

and in fact there was one thin place in it, yet the greatest part of the break was through metal that was of nearly full thickness; that is, 5/16 inch. Instead of the metal breaking off square, it pulled in two diagonally, as shown in Fig. 4.

There is no doubt but that the sheets were damaged by overheating, but whether it happened at this particular time or not will probably never be known, for while the boiler has evidently been in its present location for probably six years, according to the manufacturer, there is no record at the city hall as to just when it was installed, or whether it was ever inspected by the city, and there was no boiler insurance carried. The negro porter was evidently in charge of the boiler at the time, and he was one of those who were killed.

Between the boiler dome and the smoke-stack breeching was a 7-inch header running south across the basement. This header was standard 7-inch pipe and the fittings were mostly of the screwed type, the end over the boiler terminating in a 7-inch screwed elbow, looking toward the dome. This elbow had a piece broken out of it, and lying on the floor near the exploded boiler was a piece of 7-inch pipe about 30 inches long, flanged on one end and threaded on the other. This piece would just about fit in the space between the elbow and the fittings on the dome. The threads on the end of this piece were in good condition, so it is possible that the steam fitters intended to replace this elbow with a tee and may have broken the elbow in order to get the short piece of 7-inch pipe out.

Near the spot where the piece of 7-inch pipe lay, the fittings, shown in Fig. 4, were also found. There was a 7-inch standard screwed tee; in one end of the run was a 7-inch nipple about 14 inches long, on the end of which was a flange, the mate to the flange on the piece of 7-inch pipe. These flanges were not broken, nor were there bolts of any kind in them, so that they were evidently disconnected at the time of the explosion.

On the other end of the tee was a bushing and a 3½-inch nipple to which the safety valve was screwed. The inlet of the safety valve which is ordinarily connected to the boiler was plugged, and steam entered the usual outlet opening to the steam main. The side outlet of the 7-inch tee had a bushing, reducing the outlet down to 6 inches to receive a 6-inch nipple carrying a screwed valve on the opposite end.

On looking at the dome of the boiler I saw that the flanged opening in the dome was 7 inches in diameter, but in it was a 7x6-inch screwed bushing, and into the bushing was screwed a 6-inch nipple about 6 inches long. The end of the nipple was crushed in a little, so that it is probable that the valve must have been screwed onto it. I stuck my hand into the valve and found it shut. "Under such conditions a sheet 1 inch thick could not stand a combination like that," were the words of a boiler inspector standing nearby.

Now while the sheets showed that they had been burned at some time, and also that they were evidently weakened enough to break before the seam, yet I could see no possible combination of these fittings that would permit of any arrangement except with the stop valve between the boiler and the safety valve, when the horizontal position in which the safety valve must be set in order to operate is considered. If such was the case, the steamfitter evidently shut the valve to work on the 7-inch line, and when the pressure became high enough, the boiler exploded.

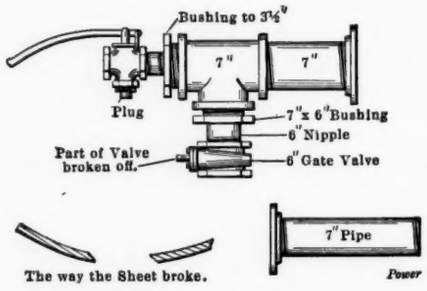


FIG. 4. FITTINGS FOUND IN DEBRIS

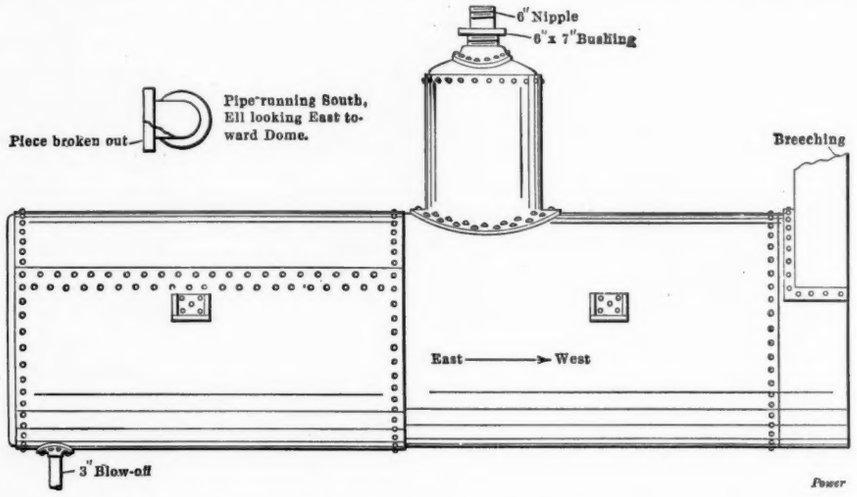


FIG. 5. THE BOILER BEFORE THE EXPLOSION

Water Powers in the Pacific Northwest

BY AUGUST WOLF

Contending that the tendency of the Federal Government to assume control of the water-power sites and coal lands in the Pacific Northwest is wrong and firm in the belief that the natural resources are the inherent property of the States in which they are located, the chambers of commerce and commercial organization of Washington, Oregon, Idaho, Montana and other States in the Rocky mountain country are contemplating open opposition to the policy of the department of the interior. The various branches of the American Mining Congress will assist in this action and it is expected to enlist the aid of agricultural associations and others interested in the movement.

As to water powers, it is recommended that the Federal Government retain title to such powers and sites. Steps already have been taken looking to Federal retention of all such powers and power sites not already in private ownership.

The data now in the hands of officials at Washington, D. C., show that of all the water-power possibilities in the United States, the States of Washington and Oregon have one-third within their borders. The presumption is that of the remaining two-thirds the Rocky mountain and Pacific coast States have within their borders one-half. This power is estimated at 37,000,000 horsepower, so that the Rocky mountain and Pacific coast States possess within their borders 25,000,000 horsepower possibilities, say, one-half of which is developed, and we have remaining at least 12,000,000 horsepower possibilities which have not passed to private ownership.

If the Federal Government retains title to this immense power yet undeveloped in these States, and of this Washington has about 5,000,000 horsepower yet without transfer, and the ultimate development of this power returns a revenue of but 25 cents a horsepower each year the group of States mentioned will be contributing $3,000,000 to the Federal treasury and the State of Washington will donate the princely sum of $1,250,000 as its share.

High Pressure Steam Piping

Typical Systems and Schemes Used in the Arrangement of Steam Piping for Power Plants with Some Mention of Special Fittings and Pipe Bends

BY PERRY WEST

Some of the general features of this subject are applicable to all classes of power-plant piping and will be treated accordingly. It is the writer's opinion that there is a greater need for discussions of the underlying principles of piping design than there is for examples of the various practices which are being employed. The examples are, of course, useful, and it is necessary to know what practices among these are proving successful. There appears to be a lack of information which would tend to an intelligent discrimination between the good and bad features of the examples already before us.

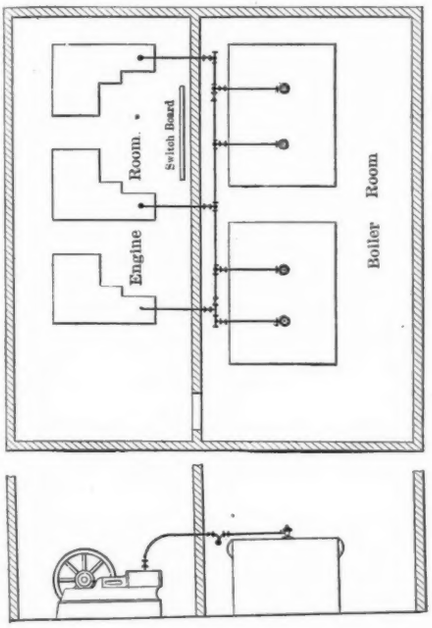


FIG. 1. BACK TO BACK ARRANGEMENT

The life of piping is now considered one of the most important questions connected with the plant. The quality of material and workmanship control this to quite a considerable extent; but even the best materials put up by the best workmen cannot be made to stand the excessive strains and vibrations imposed by modern requirements unless they are properly cared for in the design. Special designs are becoming more popular every year. Often by the expenditure of a comparatively small amount on bends or special fittings very large savings in economy and space can be effected. Former practice seems to teach that the once much thought of duplicate system is not altogether satisfactory for preventing shutdowns. The general method now is to use one system and to leave in this as few opportunities for breakdowns as possible. To this end we may note that quite a bit of study has been given to designs of this kind in the past few years. Engineers have also come to learn the true value of the losses due to bad piping and are constantly striving to reduce these to a minimum. The realization of the fact that it is easier and better to make piping special than to discommode a whole plant is also bringing out many new and useful designs in this connection. It certainly behooves the engineer to make his piping as good as any other part of a plant, and in this age of such durability and economy in plants, the piping must be of the very best.

Notwithstanding the fact, therefore, that the piping is a very small part of a power plant, it has come to be one of the leading questions with the power-plant engineer. It is one which always has to be solved by him regardless of the disposition of many others which should be.

SYSTEMS AND SCHEMES

Regarding systems and schemes, much might be said for which space cannot be taken here. A discussion of some of the fundamental features of the most popular practices only will be attempted.

Of the points to be considered, may be mentioned the following:

(1) Economy, convenience and reliability.

(2) Operative facilities.

(3) Flexibility.

(4) Special provisions for extensions and tests.

The dictates of economy are that runs shall be as short as possible. Convenience is also generally found in a compact arrangement if ample passage ways are provided. For small plants the "back to back" arrangement, as shown in Fig. 1, is a good one. For larger installations, the "unit system," as shown in Fig. 2, has recently become very popular. In this latter system each prime mover has its complement of boilers separately piped and connected.

A properly valved tie over line forms a cross connection for the several units in case of a breakdown. This system has several advantages over others for cases to which it is properly applicable. The principal conditions which decide for or against it are: size of installation, desirability of operating sections of the plant separately, and the question as to whether boilers and engines work out to even lengths, if disposed in two single paralleled lines.

The division of a plant into units tends to localize breakdown troubles and allows an easy division of the operating force into crews, having each the particular care of one or more units. The latter feature helps to fix responsibility, and may also be the means of dispensing

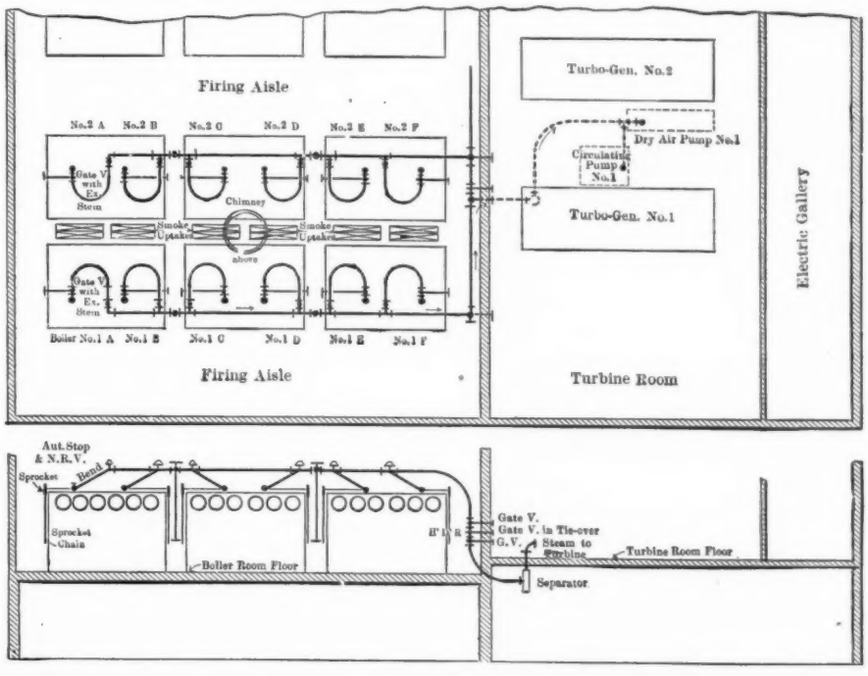


FIG. 2. UNIT SYSTEM FOR LARGE PLANTS

with certain crews on the low-load shifts. The economical operation of most any plant requires that different combinations of the units be operated on the different loads.

In the unit system it is possible to close down a corresponding proportion of the boilers every time a prime mover is taken out of service, thus cutting down unnecessary heat losses and allowing more time for repairs. If this unit system is extended to the auxiliaries, as shown, these may also be simultaneously closed off, with the consequent savings of radiation from their piping. This arrangement is convenient for testing, as each unit may be isolated and tested or compared with the other units as to steam and coal consumption. Future extensions are also easily made.

Most of what has just been said regarding the unit system as applied to large plants with cross fire aisles, is equally true of the smaller plant with two parallel lines of boilers and engines. The main difficulties in its application to the smaller plants are that it may necessitate a division of the boilers into units too small for practical results, and that extra valves, etc., may increase the cost of piping above that warranted by the size of the installation.

A number of small boilers may require a room out of proportion in length to that of the engine room, and, as already mentioned, this is another factor which usually works against the unit system for small plants. If in such cases a unit arrangement is used, the layout shown in Fig. 3 is recommended.

The Spider System

The "Spider" system, as shown in Fig. 4, is also good practice in many small plants. In this arrangement the boiler leads are brought to one central header from which the supplies are taken for the various units. This main header is made as short as possible, being just long enough to contain all valves and outlets. It should be of the very best construction. The valves for controlling the inlets and outlets are placed on the opposite side of a wall, wherever possible, and are arranged to be operated by extension stems, so that in case of a breakdown steam may be closed off and changeovers made without closing down the plant. The shortness of such a header minimizes dangers from breakdowns in it, and brings all the principal valves close together. Operation is simplified, due to the fact that it is not necessary to search out the valves to be operated. The lines leading to any particular unit and its auxiliaries may be easily closed down at the time the unit is taken out of service. The shortness of the header also gives small surface for radiation. The principal disadvantage of this system is its rather awkward appearance.

Fig. 6 shows a "Spider" system employing a header without valves. The disadvantages of this, as compared to the one shown in Fig. 4, are that a breakdown inside of any of the branch valves necessitates closing down the entire station, and may cause serious accident, due to the release of steam from the entire boiler plant. Normally, the header, Fig. 4, may be operated with all its valves closed, in which case the blowing of a gasket or other accident in one section will not allow the escape of steam from all the boilers; thus minimizing the dangers from such accidents and preventing the closing down of more than one unit. It may be said of the header without valves that it is much cheaper, and that it may be made shorter, thus reducing radiating surface and the quantity of material subject to pressure. The elimination of the joints at valves is also in its favor. It should be remembered, however, that if, with the addition of joints, a valve is added which will protect a number of units, not only from accidents to the added joints, but from many others, the balance is in favor of the extra joints and valve, as far as reliability is concerned. As to additional cost for valves, these may be made smaller than the header, owing to their emergency character and the shortness of run. The sections of a valved header should be made of cast steel or by welding nozzles to steel pipe, so as to decrease the danger of rupture to all sections in case of accidents to one. The valveless header may be made of boiler plate or by welding nozzles on to steel pipe, and may in this particular

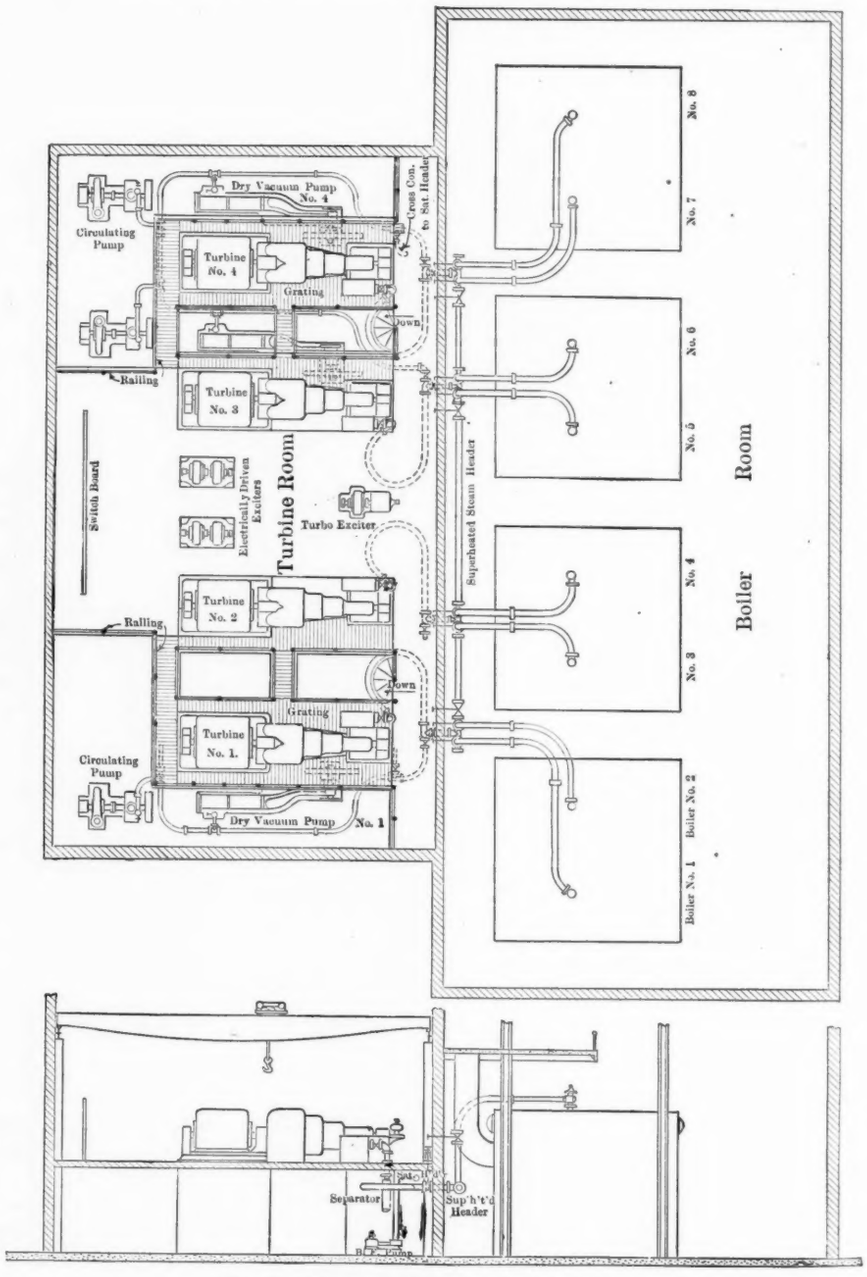


FIG. 3. UNIT SYSTEM FOR SMALL PLANTS

possess some advantages over the valved one as to ease of construction.

Fig. 5 shows a ring header, which is perhaps the best form of a duplicate system. Its chief disadvantages are: excessive first cost, together with the liability of getting neither branch quite as good as one main might otherwise be made, the liability of one branch being closed down for repairs and remaining so until the other side also breaks down, and the inconvenience of future extensions. In case of a single header, repairs are made promptly on account of their more urgent need. In some instances the ring header may be used without much additional cost, and if other conditions and requirements are especially favorable, may be advantageous.

In most plants, especially if condensing, it is desirable to have some of the apparatus located below the engine-room floor. The boiler-room floor, on the other hand, may be designed as low as possible, so as to increase facilities for handling coal. These conditions often result in a difference of from 6 to 12 feet in floor elevations, the engine-room floor being the higher. In such cases the header is run either very low or very high, relative to boiler outlets. The use of a traveling crane over the engines sometimes prohibits the running of the engine connections near the ceiling, in which case they may, with better results, be carried over under the engine-room floor. In this case it is advisable to have the header low, so that the connections may be taken from the top and fall toward the engines. The placing of engine connections below the floor helps the looks of a plant, and they may be brought up to the throttles with semi-circular pipe bends, or be run direct with valves below and floor stands above.

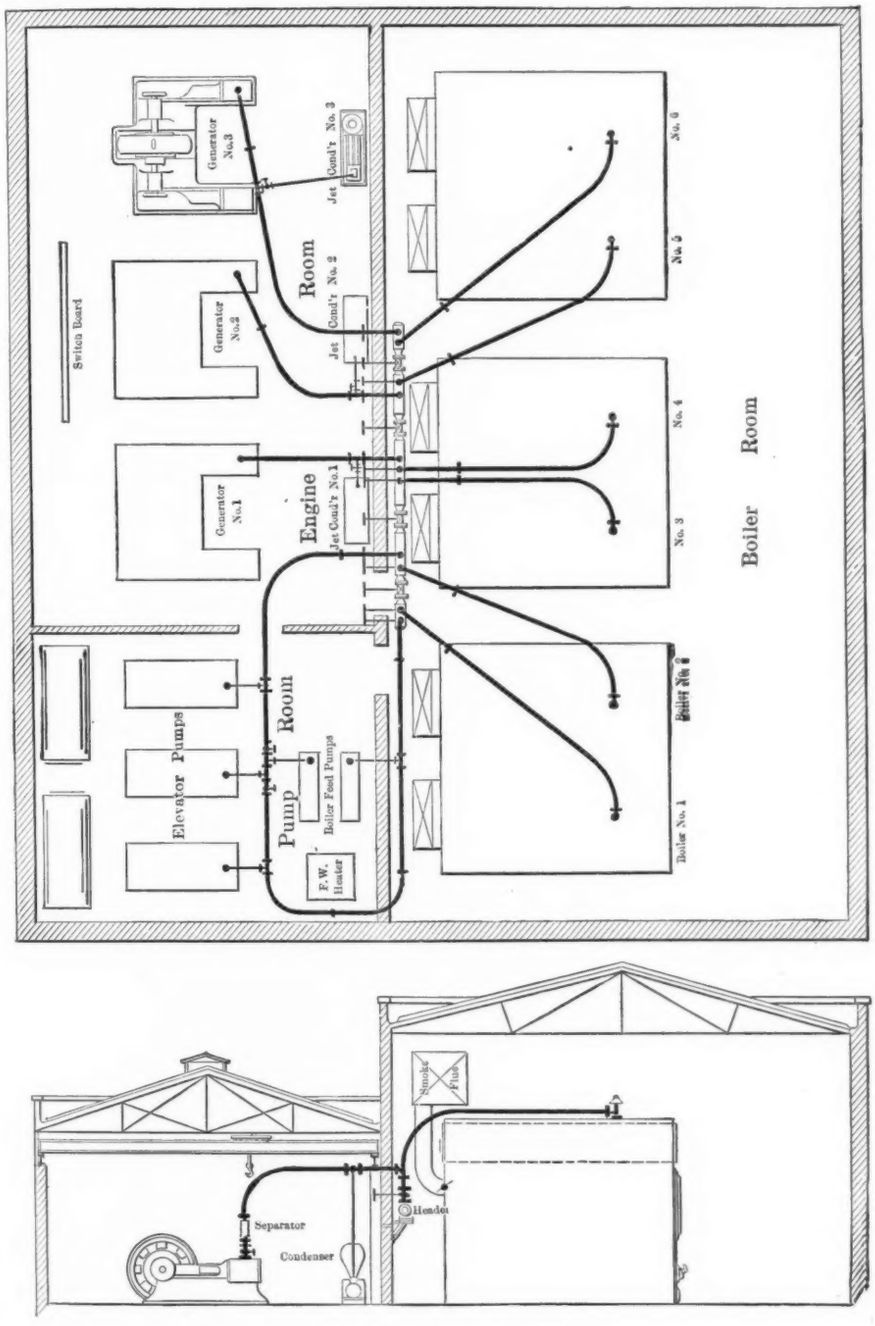


FIG. 4. SPIDER SYSTEM

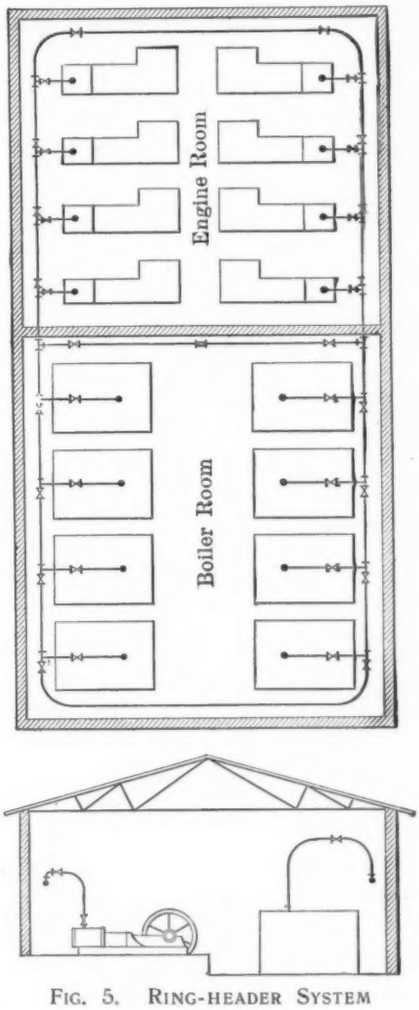


FIG. 5. RING-HEADER SYSTEM

For special fittings, branch tees, "spider" headers, etc., nozzles and flanges welded to steel pipe are perhaps more durable and reliable than cast steel. In Fig. 4 is shown a header of this character.

Fig. 8 shows several special fittings and the uses to which they may be put.

PIPE BENDS

In providing for flexibility against expansion, vibration and other movements, pipe-bend connections to fixed points and between large mains are recommended.

Expansion joints of various types are used to some extent, but their liability to leak, stick and give trouble otherwise has operated in favor of substituting pipe bends wherever possible. The force of lineal expansion in pipe lines is generally conceded to be practically irresistible, and the whole movement between any

anchorage and a connection should be allowed for in designing the connection. It is not necessary that all of the movement shall take place on one side of the neutral or no strain position. In other words, a cold strain may be put in the connection by having the main shorter (by about one-half the estimated expansion) than the layout calls for. By this means the connection is strained in one direction when the system is cold and in the opposite direction when hot. The cold strain is gradually lessened as the temperature rises, and after passing through zero is gradually increased in the opposite direction to a maximum at the highest temperature. For connections to long lines, where considerable expansive movements acting in one direction only would produce excessive stresses, this method is quite useful. In using cold strain, it is important that the anchorages be properly located and of heavy construction. Also that the allowance in length of the piping, as erected, be exactly right for producing the correct cold strain, otherwise the advantages to be gained are lost.

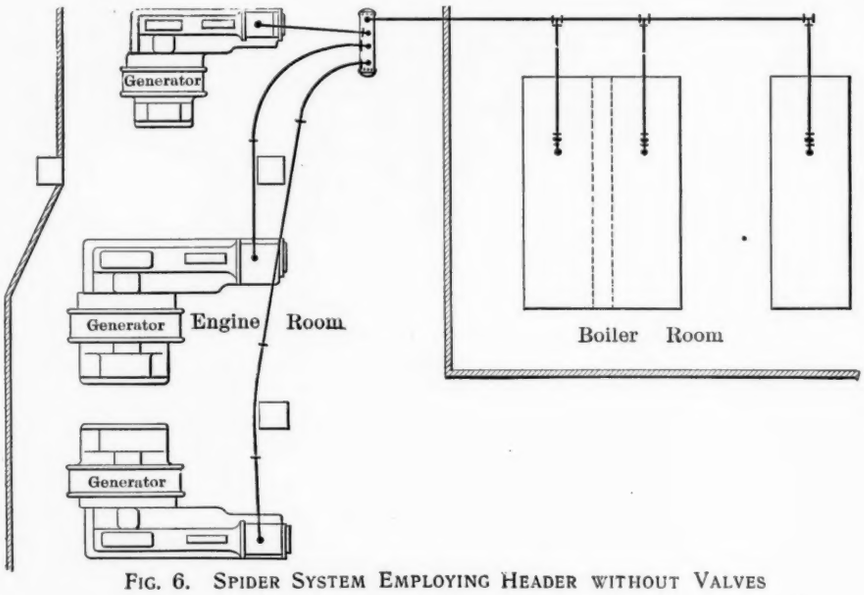


FIG. 6. SPIDER SYSTEM EMPLOYING HEADER WITHOUT VALVES

The anchoring of any system, whether cold strain be used or not, is very important.

All the neutral points should be securely anchored to substantial, fixed points, so as to divide expansive movements correctly between the several connections. Relying on the connections as anchors allows the larger ones to transfer most of the movement to the smaller or weaker ones.

Fig. 7 shows an arrangement of this description which, as can be seen, works out very satisfactorily.

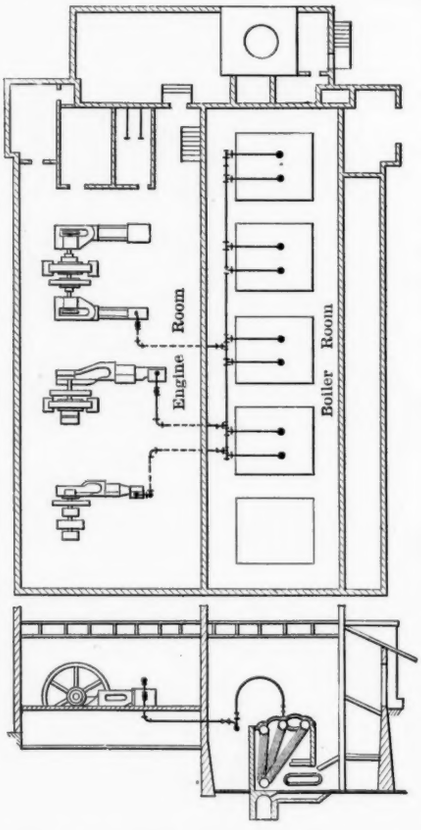


FIG. 7. GOOD DESIGN OF PIPING FOR ANCHORING NEUTRAL POINTS

SPECIAL FITTINGS

Regarding special fittings, it may be said that their use is generally advisable wherever joints may be avoided by doing so. In dealing with superheated steam at high pressure, the elimination of joints means a great deal toward diminishing the possibilities of breakdowns and lessens operative and maintenance charges. Gasket troubles, which multiply fast with increase of pressure and are especially hard to meet with superheated steam, are reduced. Wherever several outlets may be brought close together, a multiple outlet tee is usually advisable, in the long run, regardless of its possible additional first cost. Tees and fittings of special dimensions are usually preferable to standard ones with short "fillers" between. Long-radius ells are no doubt advisable for high-class work as compared with standard-radius fittings. Pipe bends have supplanted the special-radius fittings, however, owing to their greater durability and flexibility.

Of the joints, it may be said that nothing new has been put forward in the past few years. All of the well-known types such as the "peened flange," "Van Stone," "shrunk flange," "welded flange" and ordinary "screw flange," are still serving their particular purposes. It is not the purpose of this paper to elaborate on the details of each of these joints or to compare their adaptabilities to the different services. It may be said generally, however, that joints of the "Van Stone" and "welded flange" types have undergone considerable recent improvement. In Van Stoning, the end of the pipe is upset before being rolled over, so as to give extra thickness to the metal in the bend and for facing off. The ring flange is faced on all sides, thus giving an even bearing between the flange and the pipe. Improvements in methods have also brought the price of such improved joints down within reasonable reach of the screw or shrunk flange joint. Methods of manufacturing the welded flange joint have also been improved to a point where its cost is not so prohibitive.

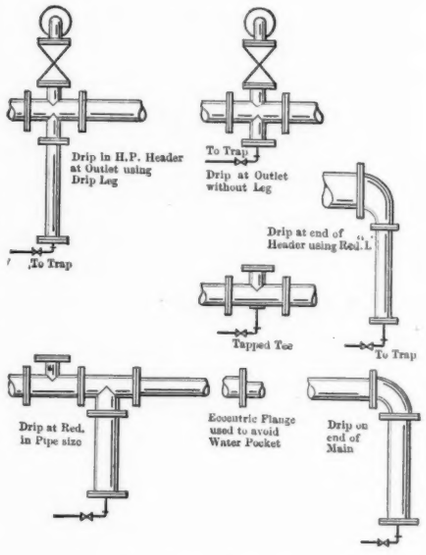

Drip in H.P. Header at Outlet using Drip Leg
To Trap
To Trap
Drip at Outlet without Leg
Drip at end of Header using Red. L
Tapped Tee
To Trap
Drip at Red. in Pipe size
Eccentric Flange used to avoid Water Pocket
Drip on end of Main

FIG. 8. DRIP CONNECTIONS

The materials employed for high-pressure work have changed somewhat in the past few years. Cast-iron fittings and valve bodies are still used with saturated steam below 200 pounds pressure. Above this pressure and for superheated steam, cast steel is recommended. Recent tests and experience show that cast iron or semisteel deteriorate in tensile strength very rapidly under temperatures corresponding to 200 pounds or more.

Cooling Towers for Steam and Gas Plants*

Types of Tower in Current Use and the Principles upon Which Future Development Should Be Based to Secure Maximum Efficiency with Minimum Volume

BY J. R. BIBBINS

That the possibilities of the cooling tower have not been more widely recognized results from the impression that it is but a makeshift at best. This impression is largely due to lack of definite data relative to its performance under unfavorable weather conditions and to the belief that the present high prices prohibit its more widespread adoption.

There is, however, a continual demand for cooling towers for inland plants where the condensing-water supply is costly or restricted. The increase in demand will keep pace with the increase in the number of turbine and gas-power installations, for it is in these fields that conditions are most favorable for their successful operation.

Cooling towers may be grouped roughly into four classes, to wit: atmospheric, natural draft, mechanical draft and auxiliary draft.

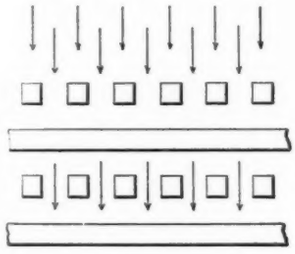


FIG. 1. FILLING FOR NATURAL- OR MECHANICAL-DRAFT TOWERS

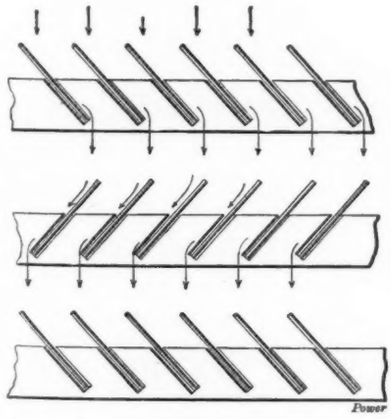


FIG. 2. FILLING DESIGNED TO AVOID FREE FALL OF WATER

Atmospheric cooling systems include ponds and towers which are open on all sides. They depend upon natural currents to supply the required amount of air for cooling the water. Perhaps the simplest atmospheric system is the pond with the cooling water being discharged into it from suitable nozzles in the form of a spray. A more common type, and one requiring less ground space, is the tower. In this type the descending water is kept finely divided into numerous minute cascades by various devices such as arrangements of perforated shelves or trays.

Any atmospheric cooling system must be located in an open space so as to take advantage of air currents from any direction. Atmospheric systems are cheap to build and maintain. To their disadvantage, is the fact that, due to loss by windage, they require considerably more make-up water than any other type.

In natural-draft towers the descending water is inclosed on all sides, the tower being open only at the top and bottom. By this arrangement advantage is taken of the draft caused by the air becoming heated and charged with vapor as it passes up through the warm water. Hence this class of tower does not depend entirely upon atmospheric conditions for its operation.

The arrangement of the filling in various types of inclosed tower varies greatly. The aim in each instance is to bring the air and water into the closest possible contact. One design of filling is shown in Fig. 1. This consists simply of tiers of horizontal wooden bars usually made of cypress. Alternate tiers are arranged at right angles, thus more effectively interrupting the fall of water. The water is distributed at the top of the tower by spraying nozzles, or pipes or by Barker's mill, which is a radial arm distributer propelled by the lateral reaction of its own jets. It is charged that this arrangement of filling seriously impedes the upward flow of air and consequently is not well suited to natural-draft towers.

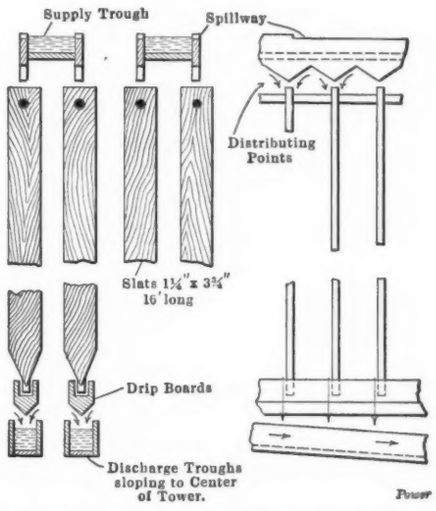


FIG. 3. FILLING WHICH SUCCESSFULLY AVOIDS FREE FALL OF WATER

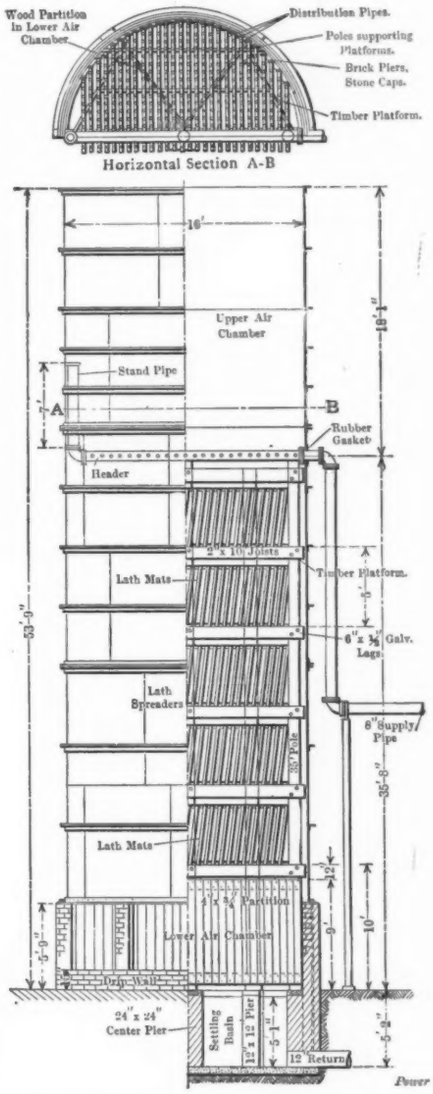


FIG. 4. EXPERIMENTAL NATURAL-DRAFT TOWER AT DETROIT, MICH.

A tower of German design uses the arrangement shown in Fig. 2, the endeavor being partly to utilize the inclined deflecting surfaces, over which the water runs in a thin film, as a cooling medium. It is doubtful, however, if this end is gained as the air impinges on the under side of the deflectors and not on the upper wetted surface.

*Abstract of paper presented before the last annual meeting of the American Society of Mechanical Engineers.

A principle which the author believes to be correct is embodied in the design shown in Fig. 3. Here we have the filling arranged so that there is practically no freely falling water. The water leaves the supply troughs over shallow spillways and is guided by the saw-tooth shaped sides onto the vertical slats; down these it runs in a thin film and is collected by drip boards into the discharge troughs. Other designs, employing the same principle, have continuous surfaces of corrugated galvanized iron or of wire cloth onto which the water is carefully guided to avoid any free fall.

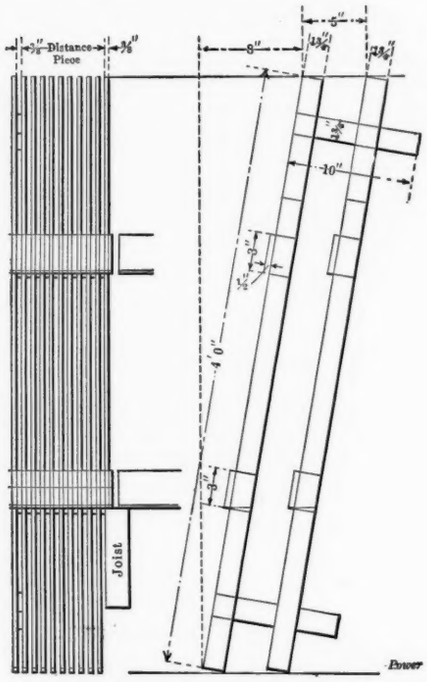


FIG. 5. DETAILS OF SECTIONAL MAT SURFACE

A natural-draft tower designed by Alex Dow of the Detroit Edison Company is shown in detail in Fig. 4. The tower cools water for a 1000-horsepower, engine-driven plant. The filling consists of mats made up of common wooden laths and arranged as shown. In Fig. 5 are shown the details of the mat construction. The rough finish of the laths makes a very desirable cooling surface as it serves to keep the water in constant agitation. The sloping arrangement of the mats prevents the water from falling free for any great distance and also constrains the ascending air to slice upward through the interstices, thus bringing both sides and both edges of the laths into use as cooling surfaces. A cooling surface of approximately 20 square feet per running foot of mat is obtained.

Uniform water distribution is obtained by an arrangement of piping, a detail of which is shown in Fig. 6.

The total cost of construction, including material and labor, was in the neighborhood of $1350. Had the shell, which was built of steel, been constructed of wood, the cost could have been still further reduced. This design, besides having in its favor a low construction cost, offers the further advantage of being easily and cheaply repaired.

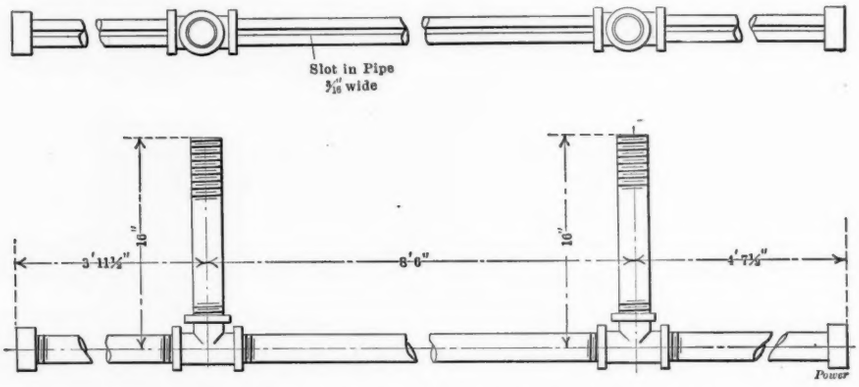


FIG. 6. DETAILS OF PIPING FOR WATER DISTRIBUTION

Two tests were made on this tower. During one test only the two upper tiers of mats were in place while, during the other, all the mats were in position. The results of these tests are given in Tables 1 and 2. In Table 3, results obtained with this tower are compared with results obtained with a forced-draft tower at another plant. The curve in Fig. 7 shows the cooling rates of the natural-draft tower when all the surface was in use and when only ⅗ of the surface was in use. In Fig. 8 a comparison is made between the cooling capacities of the natural-draft and forced-draft towers under various differences in temperature between the water to be cooled and the outside air.

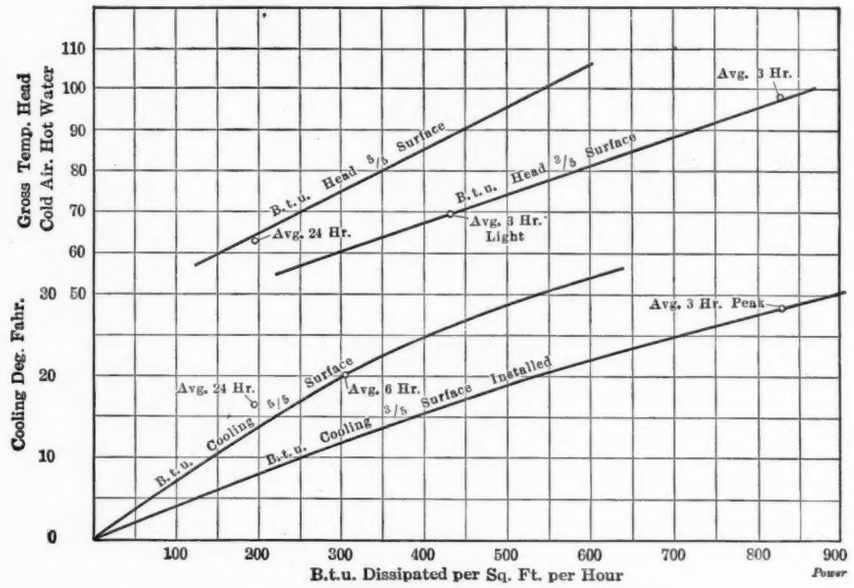


FIG. 7. RATE OF HEAT DISSIPATION OF THE DETROIT TOWER

It was found that the efficiency of the natural-draft tower was only slightly less in summer than in winter. Apparently the increased rate of evaporation made possible by the higher air temperatures of summer offset the greater conduction of heat due to the lower temperatures of winter.

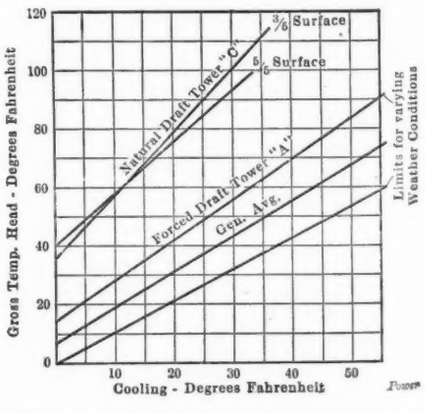


FIG. 8. LOST HEAD OF NATURAL- AND FORCED-DRAFT TOWERS

Cooling towers, just the same as any

TABLE 1. TEST OF NATURAL-DRAFT COOLING TOWER, DETROIT.

INCOMPLETE, THREE-FIFTHS SURFACE INSTALLED.

Time.	Temperature, Deg. Fahr.					Quantities.				
	Air.	Hot Well.*	Cold Well.	Water Cooling.	Total Heat Head.†	Tower Water Lb. per Hr.	Heat Dissipated B.t.u. Lb. per Hr.	Heat per Sq.Ft. Cooling Surface, B.t.u. per Hr.	Circulating Water per Sq.Ft., Lb. per Hr.	Load Kw.
1	2	3	4	5	6	7	8	9	10	11
12 noon	34	102	89	13	68	375,000	4,880,000	332	25	270
1.30	35	106.5	90	16.5	71.5	§{375,000 / 370,200	6,108,000	415	24.8	{315 / 290
2.30	35	106.5	87.5	19	71.5	375,000	7,120,000	484	25	315
3.30	35	113	88.5	24.5	78	375,000	9,000,000	613	25	350
4.30	32.5	100	84	16	67.5	399,000	6,384,000	434	26.6	365
5.00	28.5	103.5	88	15.5	75	445,500	6,900,000	470	29.7	485
6.00	26	125	94	31	99	417,000	12,930,000	880	27.8	655
7.00	24	121	94	27	97	427,000	11,532,000	785	27.4	570
8.00	24	123	94.5	28.5	99	427,000	12,174,000	827	27.4	600

*Assuming a more efficient condenser, say 10 deg. difference, the probable vacuum would be 26 deg. to 27.5 deg. This condenser actually operated at 40 deg. to 50 deg. difference.
†Total heat head = air heating + lost head.
§Difference due to rapid change in load.

TABLE 2. RESULTS OF TEST OF NATURAL-DRAFT TOWER, DETROIT.

COMPLETE, FIVE-FIFTHS SURFACE INSTALLED.

Engines:	Two 400-i.h.p. 300-kw. MacIntosh & Seymour tandem-compound engines, overhung generators.				
Condensers:	Worthington surface (admiralty type) 1600-sq.ft. reciprocating wet-air pump and circulating pump.				
Tower:	Wood-mat construction, 24,500 sq.ft. evaporating surface, exclusive of shell.				
Test:	March 15 to 16, 1901, 4 p.m. to 4 p.m., 24 hr.				
		A.M.	P.M.		AVERAGE.
Weather:	Barometer (abs.), min	30.22	30.07;	30.14	30.27
	Temperature air, deg	18.5	25;	30	25
	Relative humidity, per cent	76	82;	58	72
Load:	600 kw. max. to 50 kw. min. Average				244.9 kw.
	Engine Efficiency = 92.5 = 875 i.h.p. max. Average				354.8 i.h.p.
Steam:	Weight of condensed steam per hr., lb				5,910.6
	Temperature exhaust steam, deg. F				134.38
	Temperature condensed steam, deg. F				108.78
	Weight of steam per hour, max. load, lb				13,500
	Vacuum (abs.) 25 to 19, average about				22
	Vacuum corresponding to temperature exhaust steam				25
	Vacuum possible with good condenser (10 deg. difference)				28
Water:	Circulated per hr., lb				293,536
	Temperature hot well, average, deg. F				87.50
	Temperature cold well, average, deg. F				71.27
	Vaporization loss per hr., lb				5,970
Results:	Condenser surface per kw., sq.ft				2.66
	Steam per kw. hr., lb				24.3
	Steam per i.h.p. hr., lb				16.66
	Circulating water per lb. of steam, lb				49.6
	Steam per sq.ft. condenser surface per hr., lb				3.7
	Circulating water per sq.ft. tower surface, lb				12
	Difference in temperature between exhaust steam and discharge, deg. F				47
Cooling:	Max. 20 deg., min. 3 deg.-5 deg. Average				16.23
	Heat dissipated per hr., B.t.u				4,769,000
	Heat per sq.ft. tower surface, B.t.u				195
	Heat per sq.ft. per 1000 lb. water, B.t.u				0.665
Evaporation:	Circulating water, per cent				2.03
	Engine steam, per cent				101
Tower:	Surface per kw. (average load 245 kw.), sq.ft				100
	Surface per kw. (max. load 600 kw.), sq.ft				40.8
	Surface per 1000 lb. steam max. load, sq.ft				1820
	Surface per 1000 lb. steam average load, sq.ft				4140
	Surface per 1000 lb. circulating water per deg. max. cooling, sq.ft				4.17

TABLE 3. COMPARATIVE DATA, DETROIT EDISON TOWERS.

Type.	Forced Draft, Station A.	Natural Draft, Station C.
Rated engine, i.h.p	1,500	900
Cooling surface, sq.ft	34,780	24,500
Surface per h.p	23.2	27.2
Space occupied, cu.ft	7,064	10,850
Space occupied, sq.ft	175	200
Cost complete	$3,900	$1,350
Cost per h.p	$2.60	$1.50
Auxiliaries, e.h.p	13	.....
Dimensions.		
Delivery pipe above ground	29 ft. 0 in.	35 ft. 8 in.
Hight over all	40 ft. 6 in.	53 ft. 9 in.
Hight mat section	17 ft. 0 in.	25 ft. 0 in.
Hight stack	12 ft. 6 in.	18 ft. 1 in.
Hight outlet	10 ft. 10 in.	9 ft. 0 in.
Diameter tower	14 ft. 10 in.	16 ft. 0 in.
Diameter fan	9 ft. 3 in.	.....

well designed piece of power-plant apparatus, should possess flexibility of capacity so as to meet all conditions of operation, for they are subject to the same peak loads as the prime mover. In most instances the peak extends over a very short period of time; for this reason the author suggests the "Booster" type of tower, which utilizes forced draft to boost the natural-draft capacity to peak-load requirements. Fig. 9 roughly illustrates such a tower. A small fan is arranged to deliver the extra air required by the overload conditions to the tower through four L-shaped nozzles from a concrete duct extending around the base of the tower as shown. It is believed that the nozzle arrangement would produce an aspirating effect and cause even more air to enter through the natural-draft louvres when the fan was running than when it was not.

In his discussion, George J. Foran brought out the fact that an induced-draft tower would be more economical to operate than one using forced draft as it would effect a saving in the number of fans. The fans would have to operate, however, in the hot saturated air and being more or less inaccessible, probably would not receive all the attention required for good condition.

DISCUSSION

Mr. Foran was decidedly in favor of towers using mechanical draft, contending that there are few, if any, localities where natural-draft towers would be selected when uniformly high results were desired.

In discussing the design shown in Fig. 9, Mr. Foran stated that when mechanical draft is used, all the air must pass through the fan. The object of a forced-draft tower is to build up a sufficient pressure below the filling to force through the necessary quantity of air. With the arrangement shown in Fig. 9, air would flow out through the louvres rather than up the stack. The proper design would be to have doors to close off the louvres when the fan was in service.

Edwin Burhorn took exception to the author's statement that it is necessarily good practice to avoid free falling water. As 75 to 80 per cent. of the cooling effect is produced by evaporation and as this can take place only on the surface in contact with the air, the form of cooling surfaces is of great importance. In towers where the water descends in the form of spray, the entire surface of each drop is in contact with the air, while in towers, where a film of water flows over the cooling surfaces, only one side of the film is exposed. He believes, however, a skilfully designed arrangement of mats makes a more compact tower and offers less resistance to draft, but involves more weight and greater difficulties in water distribution. When oil

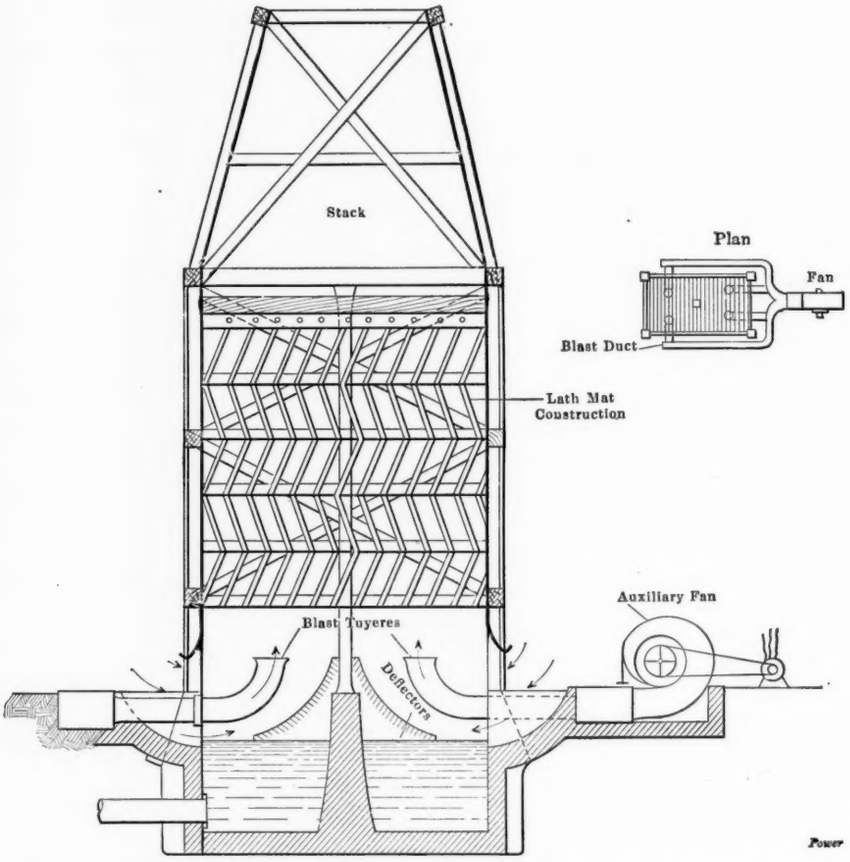


FIG. 9. PROPOSED "BOOSTER" TOWER WITH NATURAL AND AUXILIARY-FAN DRAFT

is present in the cooling water the mat surface is liable to become coated with it when the capillary effect would be destroyed and the water film changed to streams thereby greatly reducing the water surface.

A point brought out by Carl G. de Laval was that in order to obtain the best results from any type of cooling tower an efficient condenser is required. The hotter the water to be cooled and the hotter it can be returned to the condenser the more favorable are the conditions for the tower. Mr. de Laval believes we are in greater need of efficient condensers than of efficient cooling towers.

Selection of type of tower is influenced considerably by climatic conditions. An even dry climate is favorable to natural-draft and atmospheric types.

Although there are hardly two plants where the same set of factors would obtain, it is seldom necessary to provide for maximum output at the time of worst weather conditions. To illustrate, in lighting stations, the peak occurs toward night-fall when the air is cooling off and the wind, if there is to be any, is springing up; in railroad plants the peak usually comes in the morning and evening hours, while generally speaking, the worst atmospheric conditions come at midday.

Water Power from New England Watersheds

In a recent report to the New England Water Works Association, a special committee consisting of Charles T. Main, Leonard Metcalf, Richard A. Hale, Charles E. Chandler and William Wheeler, presented some valuable data regarding the water power which may be derived from specified water sheds in New England. After pointing out the danger of laying down approximate rules for calculation, this report goes on to show that for purposes of approximation, and for the benefit of those who may wish to form some general idea of the relation between the yield or flow of streams in this vicinity and the available 24-hour power to be derived from them, the following approximate general rule may be of service.

A yearly average of approximately one-tenth of one horsepower per square mile of tributary watershed per foot of fall (which corresponds to a maximum 24-hour flow or development of water of about 1.4 cubic feet per second per square mile of watershed and a maximum available 24-hour net power of 0.12 horsepower per foot of fall per square mile of watershed) may generally be obtained economically, and a correspondingly greater rate of output if the power be used for less than 24 hours per day, and sufficient pondage be available to make such concentrated use of the water possible.

Thus a watershed of 45 square miles area tributary to a dam site having an available fall of 25 feet may be relied upon to develop an approximate average 24-hour power of

$$0.1 \times 45 \times 25 = 112.5 \textit{ horsepower.}$$

From a table prepared to show resulting available net 24-hour power per square mile per foot fall from specified assumptions upon the basis of the yields of Sudbury, Nashua and Croton rivers, it appears that, for purposes of general approximation, it may be assumed that in New England watersheds without a material amount of storage and with a development up to the yield of the seventh month of an average year, arranged in the order of the dryness of those months, there can be obtained an average of approximately 0.09 horsepower (24-hour power) per square mile of tributary watershed per foot of fall, but the minimum power under such conditions may fall to one-third or less of this amount. With storage the above stated available power (0.09 horsepower) would be appreciably increased, the amount of this increase depending upon the volume and control of this storage.

In the light of all of these facts, it is perhaps safe to say, that for purposes of rough approximation for New England watersheds with some storage, there can be developed one-tenth of one horsepower (24-hour power) per square mile of watershed per foot of fall, but it must be clearly borne in mind that local conditions, character of watershed, location and elevation, storage facilities and control, cost and character of development and industry to be served will modify this figure materially.

Oil That Cold Will Not Affect

It is often difficult to keep machinery properly oiled in cold weather, as the oil freezes in the oil holes and the cups, and the oil upon the ways of the lathe and planer becomes stiff, causing the machines to work hard. A good oil for winter use is made by mixing graphite with cylinder oil until in a thick or pasty consistency, and then adding kerosene until it flows freely. This oil will not become stiff at 14 degrees below zero, and is valuable to those operating machinery outside or in cold shops.

ELECTRICAL DEPARTMENT

Especially conducted to be of Interest and Service to the men in charge of the Electrical Equipment

Primer of Electricity

Electromotive Force

If you take a piece of wire in your hands, holding it near the ends so as to leave the middle stretch free, and pass the wire rapidly across the magnetic field produced by a powerful magnet, the cutting across the magnetic lines by the wire will induce an electromotive force (electrical pressure) in the wire. Fig. 25 illustrates what is meant; the wire is held slightly above the poles of the magnet, as indicated at the left, and then carried suddenly downward to the position shown on the right. Even with the most powerful magnet that it would be practical to make, the electromotive force induced in the wire would be very weak, and a very sensitive instrument would have to be applied to the ends to detect it at all. But if a coil of wire be wound on a block, as shown in Fig. 26, and one edge of the block be moved quickly across the magnetic field, from the position shown at the left of Fig. 27 to that at the right, the electromotive forces induced in the several turns of wire will be added together, because all the turns are in series, and the pressure at the terminals of the coil will be measurable, provided the movement across the magnetic field is made rapidly enough.

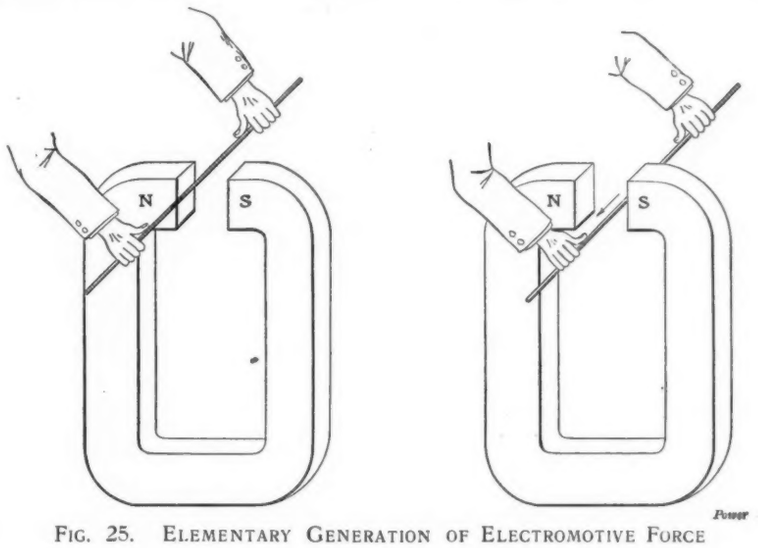


Fig. 25. Elementary Generation of Electromotive Force

The electromotive force induced in a wire by passing it across a magnetic field depends on the number of magnetic lines in the field and the speed with which the wire passes across it; that is, the total number of magnetic lines cut per unit of time. Expressed as a rule:

The e.m.f. induced in a wire is equal to the number of magnetic lines of force cut across by the wire in one second, divided by 100,000,000.

Expressed as a formula:

$$E = \frac{\Phi}{100{,}000{,}000 \times sec.}$$

in which

E = Electromotive force induced in the wire,

Φ = Total magnetic flux cut by the wire during its motion,

sec. = Number of seconds required to cut Φ lines of force.

When a wire is passed across a magnetic field in one direction, the e.m.f. induced in it will have a certain polarity; that is, it will tend to cause a current to flow through the wire in a certain direction. If it is moved across the field in the opposite direction, the polarity of the e.m.f. will be in the reverse direction. Referring again to Fig. 25, if the magnet poles be as indicated by the letters *N* and *S*, then the e.m.f. induced in the wire by moving it downward through the field will be in the direction indicated by the arrow; that is, if the ends of the wire were connected together outside the field, the induced e.m.f. would produce a feeble current flowing from the left hand to the right hand; and if the wire were moved upward, from the right-hand position to the left-hand position again, the direction of the e.m.f. induced in it would be opposite to that indicated by the arrow.

The Dynamo

A dynamo is a machine in which wires are moved rapidly across the field of a powerful magnet and electromotive force is induced or generated in each wire by this motion, as just explained. However, it is not practical to move wires back and forth across a magnetic field in a straight line, as described in the elementary examples just given, although a dynamo could be built on that plan. It is much simpler mechanically as well as electrically to put the wires on a support arranged to revolve between the poles of a magnet, and this is what is done in actual machines. The support on which the wires are mounted is made of iron in order to keep the reluctance (magnetic resistance) of the space between the magnet poles as low as possible, and for the same reason the pole faces are curved out to a circular shape and the iron support for the coils is made round, as represented in Fig. 28. The

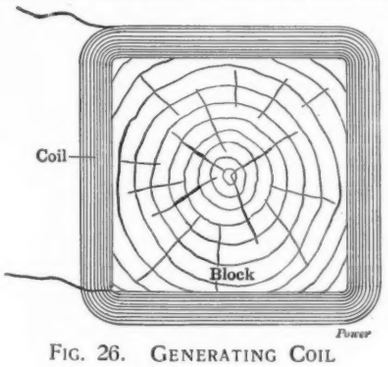


Fig. 26. Generating Coil

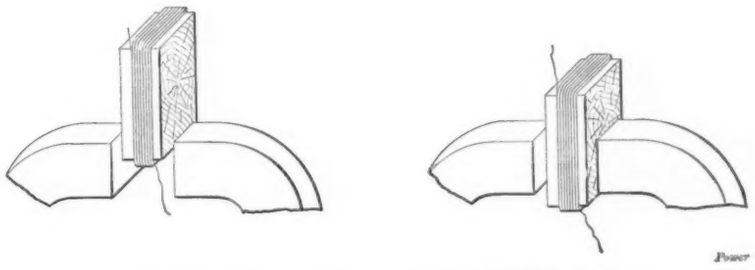


Fig. 27. Generating an E. M. F. With a Coil

iron cylinder between the poles is called the armature core and the core with the wires on it constitutes the complete armature.

Fig. 28 shows an armature core with one turn of wire on it, merely to illustrate the elementary arrangement of wire on the core. The ends of the wire are connected to the two halves of a split metal cylinder called a "commutator," one end of the wire being connected to one semi-circular part of the commutator and the other end to the other half, as shown more clearly in Fig. 29, where the left-hand sketch shows a straight end view of the commutator and the right-hand sketch a side view of the commutator and the end of the armature. The two halves, *a* and *b*, of the commutator are insulated from each other and from the drum *c* on which they are mounted; the heavy black lines represent the insulating material. This construction is purely illustrative; actual commutators are built differently, as will be explained later, the elementary arrangement here shown being used merely to illustrate the principles.

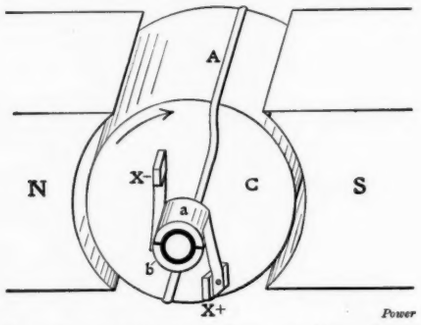


FIG. 28. ARMATURE COIL OF ONE TURN

If the armature *C* is revolved clockwise, as shown by the arrow in Fig. 28, when the wire *A* passes the face of the south pole *S* of the magnet, an e.m.f. will be induced in it which will tend to send a current through the wire from the back end of the armature toward the commutator; at the same time the wire *B*, forming the other half of the coil, will pass the north poleface of the magnet, and an e.m.f. will be induced in it in the direction from the commutator toward the back end of the armature; that is, in the opposite direction to that induced in the wire *A*, because the two wires pass magnet poles of opposite polarity at the same time and in the same direction. Therefore, if a closed circuit is connected to the brushes $X+$ and $X-$, as represented in Fig. 30, a current will flow in it in the direction indicated by the arrows, and this current will be always in the same direction, because the commutator changes the connections between the brushes and the armature wires every time the wires change their position with relation to the magnet poles. When the wire *A* is passing the south pole, the current passes from the back end to the commutator segment *a*, the brush $X+$, through the circuit and back to the brush $X-$, the commutator segment *b* and through the wire *B* to the back end of the loop; when the wire *A* has passed the south pole and the wire *B* the north pole, reaching the position shown in Fig. 30, the commutator segment *a* moves out from under the brush $X+$ and comes into contact with the brush $X-$, and at the same instant the segment *b* leaves the brush $X-$ and moves under the brush $X+$. Then the wire *A* passes the north pole and the wire *B* the south pole, and the current reverses in them, flowing from front to back in the wire *A* and from back to front in the wire *B*, but their relation to the outside circuit having been reversed at the commutator, the current in the outside circuit flows in the same direction as before.

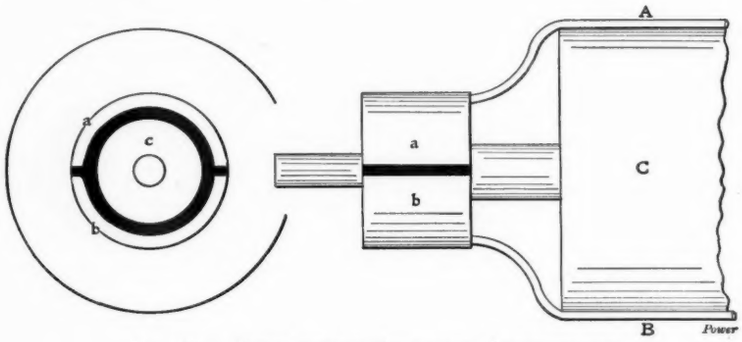


FIG. 29. ELEMENTARY TWO-PART COMMUTATOR

When the wires are passing across the vacant space between the edges of the magnet poles no e.m.f. is induced in them, and therefore no current flows in the circuit. Consequently, though the armature revolves continuously, the current in the circuit will be intermittent—it will flow when the wires are passing the faces of the magnet poles and stop when they are passing from one pole to the other. Furthermore, with only two wires on the armature the e.m.f. will be very weak and the resulting current small. In order to correct these defects, armatures are made with a great many wires or loops, connected to a commutator having many segments, instead of two, so that the e.m.fs. induced in the wires are added to each other and the connections between the outside circuit and those wires which are passing through the middle of the space between the magnet pole edges are reversed, exactly as in the elementary arrangement just described.

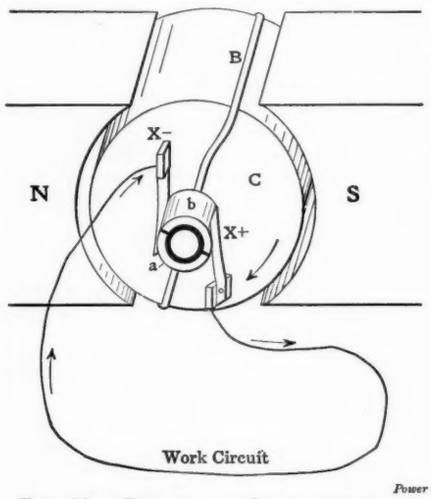


FIG. 30. EFFECT OF COMMUTATOR ON EXTERNAL CIRCUIT

A Cent's Worth of Electricity

At the average rate for power paid by the ordinary consumer, says *Harper's Weekly*, a cent's worth of electricity will operate a 12-inch fan for 90 minutes.

Will operate a sewing-machine motor three hours.

Will keep a six-pound electric flatiron hot 15 minutes.

Will make four cups of coffee in an electric coffee percolator.

Will keep an 8-inch disk stove hot seven minutes, or long enough to cook a steak.

Will operate a luminous radiator eight minutes.

Will bring to a boil two quarts of water or operate the baby milk warmer twice.

Will make a Welsh rarebit in an electric chafing dish.

Will operate a 7-inch frying pan 12 minutes.

Will keep a heating pad hot two hours.

Will operate a griddle eight minutes.

Will run the electric broiler six minutes.

Will run a massage machine nearly four hours.

Will keep the dentist's electric hammer and drill going 90 minutes.

Will keep the foot warmer hot a quarter of an hour.

Will run an electric pianola one hour.

Will vulcanize a patch on an automobile tire.

Will heat an electric curling iron once a day for two weeks.

CORRESPONDENCE

Starting a Synchronous Motor in an Emergency

It once happened that a combination of unfortunate circumstances resulted in a frequency-changing substation being shut down, one of the chief circumstances being a bursted commutator on the machine used in starting up the frequency changers. Each frequency-changing set had its own exciter mounted on the same shaft as the rotor of the synchronous motor. The usual method of starting was to employ the exciter as a motor, supplying power to it from a 200-kilowatt generator which was one member of a balancing set. It was the eruption of this balancing set which caused all the trouble, as no provision had been made for starting up the frequency changer from the alternating-current side. However, it was necessary to start up as quickly as possible, and it took but a very few minutes to go through the performance described below and get the frequency changer back on the busbars. An explanation of the normal operating conditions at this point will make the performance clearer. The arrangement of the busbars at both the substation and the generating station was such as to permit the frequency changers to be connected to one generator at the central station and be absolutely independent of the rest of the system. The generating station had two sets of busbars, designated as *A* and *B* in the accompanying diagram, each set being either split into three sections or connected by hook switches. Under normal conditions the substation was operated from the busbars *A*. The feeders to the substation could be thrown on either set of busbars by means of the hook switches *E* and *F*. Section *C* of the busbars *B* was disconnected from the rest by opening the switch at *R* and the feeder leading to that section of the substation busbars to which the frequency changer was connected was switched to section *C* by closing an oil switch at *E*. A 1500-kilowatt engine-driven generator was connected to the section *C*, leaving the generator entirely independent of any others and thereby preventing any system disturbances which might arise on account of starting up the frequency changer. The synchronous motor on the frequency changer was a three-phase 25-cycle machine, wound for 6600 volts.

When all was ready the generator was brought up to normal speed and the field excitation adjusted to give 4800 volts. At this time the frequency changer, with its field circuit open, was "cut in" on the generator by closing the oil switch *S*. The instant the oil switch was closed the ammeter showed 150 amperes and the voltage dropped to 1800 volts, though the frequency held constant. The field excitation of the generator was then adjusted until the voltmeter showed 5200 volts and the ammeter showed that the frequency changer was drawing 250 amperes. The field circuit of the synchronous motor was then closed and the current immediately dropped to its normal value and the frequency changer was running all right on section *C* of the busbars *B*.

Now, the correct connection for this substation was to the busbars *A* and, as there were no means of synchronizing

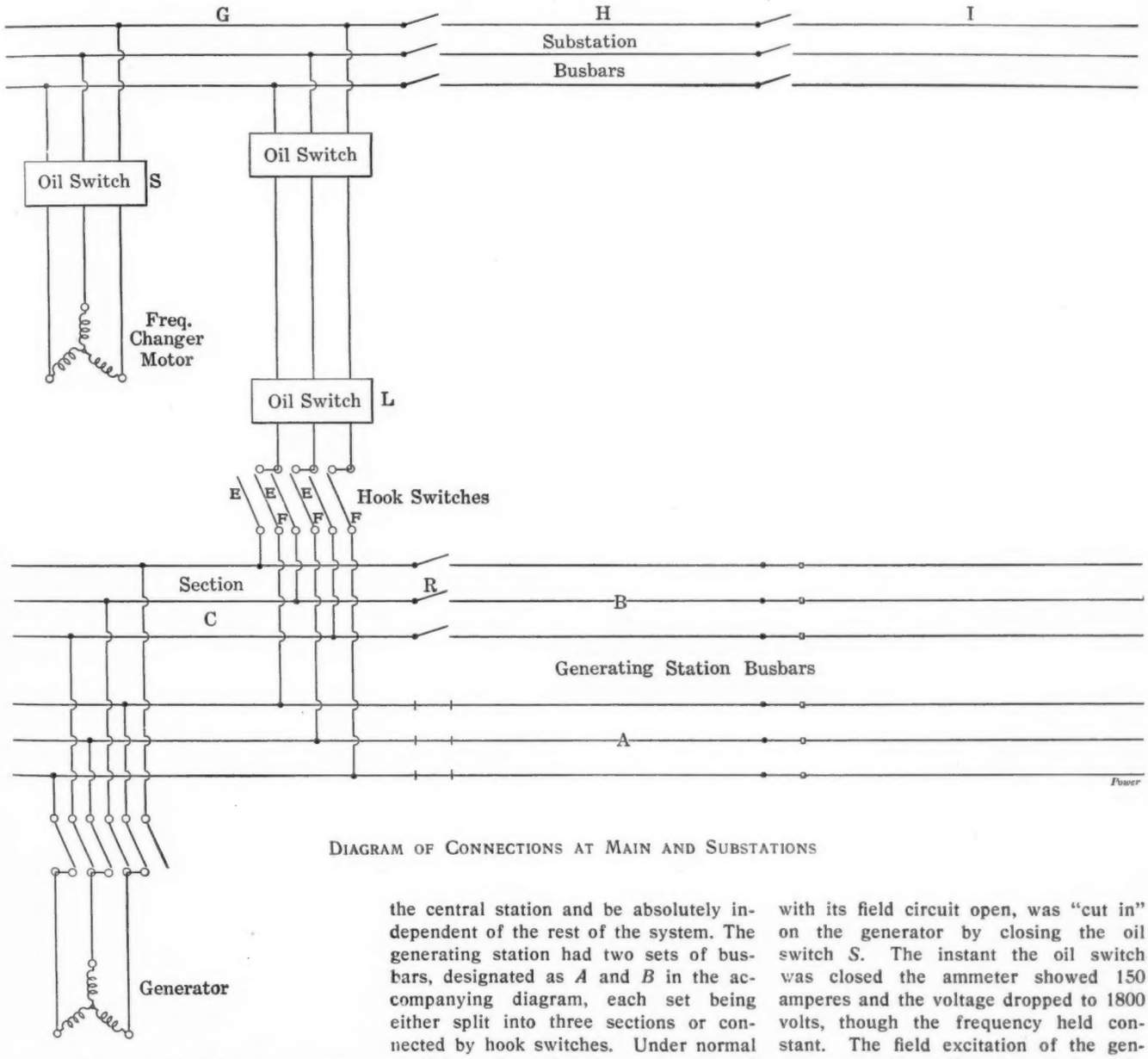


DIAGRAM OF CONNECTIONS AT MAIN AND SUBSTATIONS

section *C* of the busbars *B* with the busbars *A*, the transfer was made as follows: The substation operator opened the switch *S*, and this fact was indicated at once to the generating-station operator by the dropping of the load. The switch *L* was then opened, the hook switches at *E* were also opened, the hook switches at *F* were closed and the oil switch at *L* again closed. The substation operator was informed of the closing of the switch *L* by the voltmeter on the substation end of the feeder. As soon as the feeder was alive the switch *S* was closed and the frequency changer was running under normal conditions. The whole operation of transferring from one set of busbars to the other did not take more than a few seconds and during the time the frequency changer was off the busbars it did not lose sufficient speed to cause any great disturbance when put back on the line.

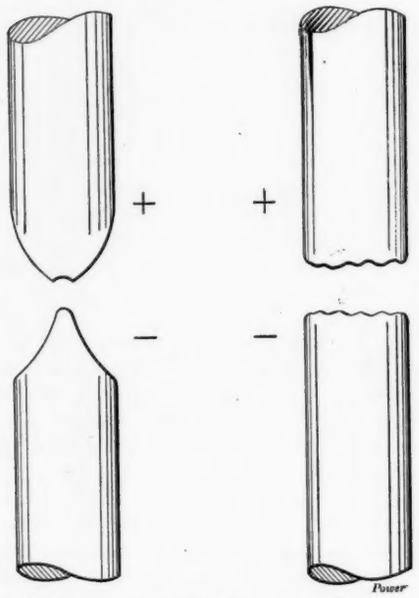
Now, it is to be expected that someone will ask why starting apparatus was not provided at the substation, but that will remain a question.

J. W. HIMMELSBACH.

Pittsfield, Mass.

Arc Lamp Carbons

In a number of issues back, R. H. Fenkhausen says that the direct-current arc lamp will burn its positive carbon to a crater-like end and its negative carbon to a point, as in Fig. 1. I have in my charge seven direct-current



CARBONS FROM DIRECT-CURRENT ARC LAMPS

arc lamps of the multiple type (shown in Mr. Fenkhausen's Fig. 2), and they all burn their carbons as shown at the right. The carbons are solid both top and bottom. The top or positive one burns about twice as fast as the lower or negative carbon. I distinguish which is which by shutting off the lamp for a moment, when the positive carbon will be red hot further back than the negative. My experience in the arc-lamp line is not nearly as broad as Mr. Fenkhausen's, and I do not know why all direct-current lamps should not burn their carbons alike.

R. MANLEY ORR.

Brantford, Ont.

Mr. Walker's Exciter Trouble

James A. Walker, in a recent issue, asked for information on exciter trouble, and from the information given concerning it, it seems somewhat strange at first thought. Before going further into this question, however, I believe I can make a suggestion to readers of POWER that will help us all very materially in the way of answering inquiries. In the first place a great many ask for information and allow the other fellow to assume too much; they either give only part information or state it in such terms that it can be construed two or more ways.

Mr. Walker's query may serve as an example of what I have in mind. He does not state whether his exciter has more than two poles, is compound-wound or runs in parallel with another; and nothing is said of its general design or its capacity. In this case there is much tc assume. The fact that the brushes are graphite and of low resistance may contribute to the trouble; it might be well to try a high-resistance brush, which would decrease the current in the brush from bar to bar while commutating. It may be that the brushes are entirely too small in area to carry the full-load or over-load current as the case may be, which makes the contact resistance so high that excessive heat is inevitable.

The statement that "The commutator runs hot with all wires disconnected from the machine" would lead one to think the cause was one of three things: All wires were disconnected except the shunt-field circuit or it is completed in the machine; the heat comes from the bearing and not from the commutator, or else it is due to the combination of armature-core losses, heat from the bearing and the brushes, and local currents in the armature, generated by residual magnetism. The last item of the combination is hardly probable.

If the exciter is of the multipolar type, either shunt or compound wound, and the armature coils are not cross-connected, there may be a condition that would cause the commutator and armature to become so hot as to melt the solder in the commutator bars, even if the machine was delivering no current to the external circuit; such a condition would exist with one damaged shunt-field coil. I have found just such a condition in several instances, and it is not always convenient to get at the trouble at once; even when it is, the job is not done in a minute, especially if the machine be a large one.

If Mr. Walker had run his exciter with no brushes, that would have told him whether the heat was due to brush friction or not. If the commutator ran cool with no brushes, it might be that brush friction was the cause, but it does not seem that, with a graphite brush and a good modern design of brush-holder, enough tension could be put on to cause excessive heat in the commutator. The fact that "if the tension is reduced, sparking occurs" would indicate that that was at least partly the cause of the trouble; then again, that could hardly be, because the heating persisted with all wires disconnected.

L. EARLE BROWN.

Roundup, Mont.

Trouble with an Induction Motor

A 75-horsepower three-phase induction motor direct-connected to a 50-kilowatt 125-volt direct-current generator, used for an exciter set in a railway power station, is shut down once a week for cleaning, looking after the commutator, brushes, etc. An autotransformer with a two-step starter switch is used to start the motor, which is of the common squirrel-cage type, operating at 400 volts. One position of the starting switch starts the motor on the autotransformer at reduced voltage and the other position cuts out the transformer, throwing the motor directly on the line. The motor comes from rest to full speed in a few seconds, yet a lower tap on the transformer will not give it sufficient speed to prevent the circuit-breaker from going out when the switch is thrown from the starting to the running position. The motor runs perfectly until shut down, after which, upon starting up again, there is sometimes a decided flash apparently from the rotor. Careful examination without dismantling the machine has failed to locate any loose bars in the rotor, neither is there any visible indication of either the cause or the effect of the flash. The rotor turns, perfectly free, running for a considerable time by its own momentum after the current is shut off. The oil from the bearing on the end from which the flash comes seems to be gradually drawn out and the coils are considerably oil soaked. A good deal of dust is collected in the rotor and blown out at each cleaning, a strong blast of compressed air being used.

The motor gives perfect service except at starting. What causes the flash?

C. L. GREER.

Handley, Tex.

GAS · POWER DEPARTMENT ·

Everything worth while in the Gas Engine and Producer Industry will be treated here for the use of practical men

Hill Bituminous Gas Producer

The accompanying engraving illustrates a gas producer recently developed by the Hill-Hupfel Engineering Company, of New York, for gasifying bituminous coals and lignite. The generator embodies a peculiar combination of the down-draft and up-draft principles, but is not strictly of the conventional double-zone type. The generator is divided into two chambers from the middle of the fire zone up to the top. The larger of the two is the fuel reservoir and the smaller is the delivery chamber. The fuel is fed into the top and the fire is maintained by a draft of air and steam delivered to the tuyere by a steam blower, as in an ordinary up-draft pressure producer. But another steam blower at the top of the generator delivers air and steam into the upper part of the fuel chamber, whence it passes down through the incandescent zone. The two currents from the upper and lower blowers meet in the incandescent zone and their pressure forces the generated gases out through the chamber to the right of the partition, as the picture appears. If the distribution of the heat zones is about as shown in the picture, it is evident that that part of the bed below the partition generates a large proportion of carbon dioxide, which is to some extent offset by the small proportion—probably none—generated in the upper part of the bed.

The lower part of the generator shell is revolved slowly through teeth around the outside and a pinion on a vertical shaft running in bearings mounted on the stationary upper part and the supporting legs. This motion keeps the hottest part of the incandescent zone in constant agitation and tends to prevent clinker formation.

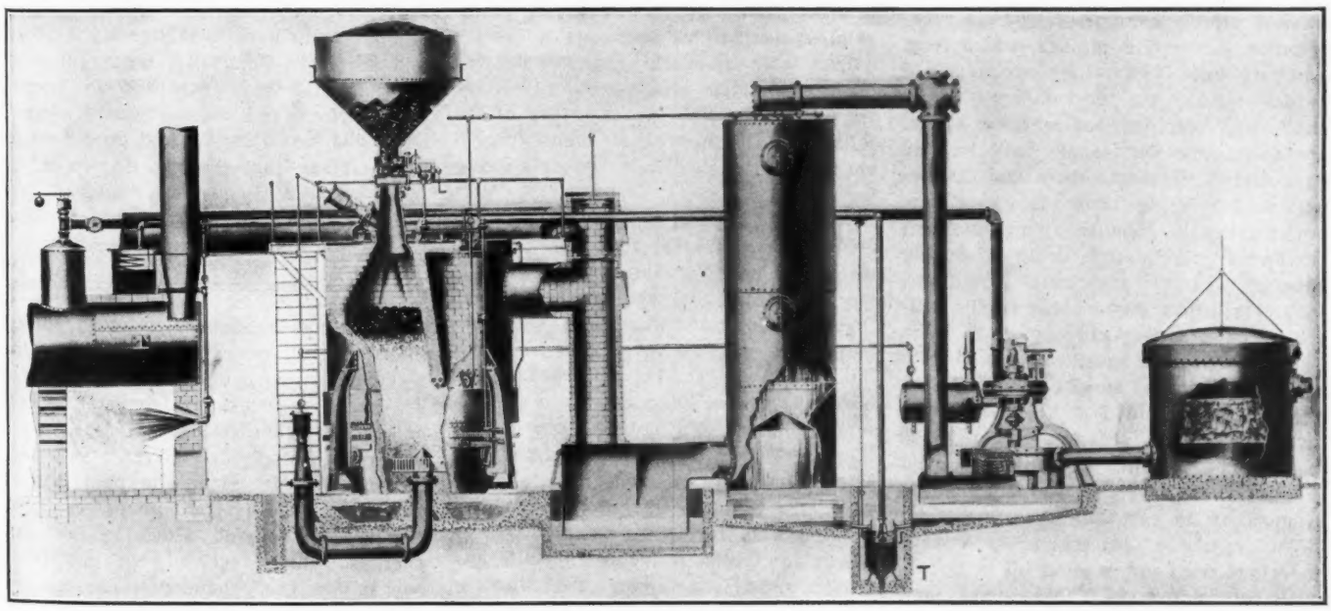
The fuel is fed into the generator from the hopper by automatic mechanism.

From the delivery chamber, the gases pass out through a large brick-lined down-comer, resting on a water-sealed sump box, to the wet scrubber. The delivery pipe of the scrubber also opens into a water-sealed sump, where impurities are deposited before the gases pass to the rotary washer shown between the scrubber pipe and the dry purifier.

Tar from the scrubber and rotary washer is collected in the small tank *T*, containing a steam coil for heating the tar. It is forced from this tank to a larger storage tank above the boiler which supplies steam for driving the rotary washer, and thence passes to burners in the boiler furnace.

The rotary washer is driven by a steam turbine, which also drives the mechanism for feeding fuel into the generator and that which rotates the lower shell. The exhaust steam from the turbine is carried to the blowers on the generator. The dry purifier is of the excelsior-packed type.

While the plant here described is of the pressure class, the builders modify it to work on the suction principle when surroundings and conditions do not admit the use of a pressure plant. In this case the rotary washer is provided with extra runners so as to act as an exhauster, and the steam is supplied by a vaporizer heated by the generated gases.



HILL GAS-PRODUCER PLANT FOR GASIFYING BITUMINOUS COAL AND LIGNITE

Operating Producer Gas Plants

BY H. B. MESSENGER

A continued experience in the operation of a producer-gas plant in a flour mill, together with some outside experience gathered by assisting others in starting new plants and overcoming difficulties after the plants had been left in charge of inexperienced operators, has served to impress forcibly upon my mind the following facts in regard to such plants.

In the first place the proper choice of a plant is of the utmost importance. A producer-gas engine, unless designed and built especially for producer gas by men who thoroughly understand that work, will always be productive of more or less dissatisfaction. On the contrary,

when properly designed and built the economy of operation is certainly all that is claimed, and the labor of operating and keeping in good operating condition, including the labor of handling the coal, is very much less than is required in a steam plant.

In the second place there should be a certain amount of adaptability on the part of the owner, if he expects to take charge of the plant and keep it in running order, or the operator, if there be a man whose duty it is to take entire care of the plant. In any event the man responsible for the plant must be a man who is able and willing to learn, who will commence with the full understanding that he is without any knowledge of the peculiarities of the apparatus, and the determination to keep his eyes and ears open until he becomes thoroughly familiar with the necessary details.

The plant will certainly come very near operating itself as long as everything is in proper condition, and will just as certainly give more or less trouble as soon as any portion of it gets out of adjustment or out of correct working condition. It is then up to the operator to discover what is wrong and adjust or remedy it. A little watching and patience will soon enable him to detect almost anything that gets out of condition at a glance, and it will soon become second nature for him to take care of such vagaries, without any great perplexity or confusion.

We can nearly all remember when the gasolene engine was considered an extremely erratic machine, yet at the present time automobile engines, which from the very duty which they are required to do must be the most difficult of all engines to keep in good working shape, are so reliable and people have become so well accustomed to them that the experienced operator starts off to go almost any reasonable distance at any hour of the day or night, often under extremely adverse weather and road conditions, with very little thought of an engine failure. The producer-gas engine is much simpler than the gasolene automobile engine; it runs at only one speed; the gas can be examined and tested at any time; the engine is much larger; it is mounted on a solid foundation, and so constructed as to allow free examination of most of its parts while in operation.

The matter of lubrication is a very important one, and a good oil is necessary for cylinders, valve stems and igniters. Almost any oil will carbonize to a greater or less extent in the cylinder or gum on the exhaust-valve stems and the igniters. It is good practice to use a little coal oil occasionally on these latter parts to remove the accumulation of gummed oil. Graphite is also very useful for this sort of lubrication. I have made a practice of pouring a small quantity of kerosene, mixed with graphite, into the air-suction pipe after shutting off the gas at closing-down time. As soon as the gas is shut off the explosions stop in the cylinders, while the engine is still sucking strongly on the air inlet, and the mixture of kerosene and graphite is drawn into the engine and thoroughly distributed among all the working parts, where it stays until the next starting time. This leaves everything in good condition to work freely when the engine is started.

It is sometimes found that, on account of the sticking of the rings, the compression of a gas engine is very poor at starting, but improves and comes all right after a short run. The use of kerosene and graphite as described will usually do away with this entirely.

Gas Power at the Gary Steel Plant

By W. M. Hampton*

A few years ago when the blast-furnace men began to use gas under their boilers and cut out the coal they imagined they had reached the hight of achievement with blast-furnace gas. Today almost entirely we are using gas engines for the production of power at Gary and the gas engine has been in a large measure bought by other companies belonging to the United States Steel Corporation. The Pennsylvania Steel Company, at Lebanon, Penn., is using gas from a by-product oven. They pipe the gas six miles and use it in engines for the development of electric power. A Philadelphia company is operating its power houses with electrical power generated by gas engines running on gas made from the light distillate or refuse of the refinery. The byproduct ovens furnish gas for gas engines and are doing very fine work.

As I said before, the highest achievement several years ago was burning water gas under steam boilers. A little more than two or three years ago the Steel Corporation went into the subject of gas engines very extensively and the result was that upward of 200,000 horsepower were bought to go in the different plants. We have at Gary thirty-three 3000-horsepower gas engines, with a large portion of them in operation; some are put into operation every day. The plant is furnishing all the electric power for the manufacture of rails and billets and is supplying the town of Cary and small concerns through the town with current from dynamos driven by the gas engines. We have only two 2000-kilowatt steam turbines, which comprise the whole steam plant.

The first that we knew of the use of blast-furnace gas engines in this country was the engine that was built for the Pennsylvania Steel Company, at Steelton, a few years ago, and owing to the inexperience of our engineers at that time it did not prove highly successful. A little while after, the Lackawanna Steel Company, at Buffalo, put in a gas-engine outfit. They have about 40,000 horsepower of gas engines of the two-stroke-cycle type and have operated with more or less success up to the present time, although I understand that their power engines are not used now because they can buy power from Niagara Falls cheaper than they can make it, but they are blowing furnaces with gas engines.

The engine cylinders at Gary are 44x 54, and the speed is 83 to 84 revolutions per minute. The compression is about 185 pounds. These engines are an absolute success; they have made runs of 30 days with 25 minutes shutdown. The alternating-current generators are running in parallel and we have no more trouble in getting them in step than you would have with any similar size of steam engine. We bring them up to speed and they go in on the line. With all gas engines, irrespective of the make or style, you have some cross currents in the generators due to various causes—sometimes the igniters, sometimes weak mixture, etc., but we do not get any more cross currents than we would on any badly regulating steam engine.

We have had no serious troubles there. We have had all the troubles any gas-engine man has had—varied troubles, like bad ignition, bad gas, etc., but we have had nothing very serious. Most of our operators have been steam engineers and the only thing that we require of them is that they know how to handle big bearings and big machinery, forget about the steam engine and do not come out and say that the gas engine is no good.—*Extract from a brief address delivered before the National Gas and Gasolene Engine Trades Association.*

*Superintendent of motive power, United States Steel Corporation's Gary plant.

According to a despatch to the daily press, the electric station at Skabersjo, Sweden, has been operating for the past five years on gas made from peat. The despatch further states that the station has a fuel supply for 30 years in a bog of 37 acres, in which the peat is five feet deep. Two 150-horsepower generators are coupled direct to two gas engines, which receive peat gas from two suction gas producers. The current is conducted about three miles to Svedala, and used for street lighting and power for several small industries. The cost to consumers is about one-half cent per horsepower-hour. Only tar is saved from the waste, but recent experiments indicate that in a somewhat larger station the sulphate of ammonia and other byproducts may be made to pay all gas-production expenses.

FROM·READERS·WITH SOMETHING·TO·SAY

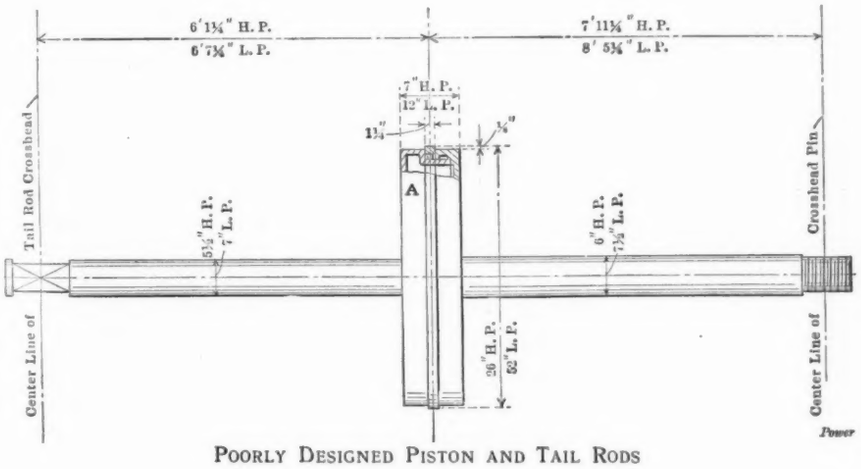
Practical Information from the Man on the Job. A Letter good enough to print is good enough to pay for

The Tail Bearing

If the piston speed and the size of an engine demand the use of a tail bearing, particular attention should be given to the size of the piston rod and the design of the piston. Rods that are too small and carelessly designed pistons give very unsatisfactory results. In many cases, where the piston speed is not too great and the piston not excessively heavy, the tail rod might be eliminated and equally good service obtained. It is the opinion of some designers that if the piston is of the built-up type, with full rings babbitted and adjustable, very satisfactory results can be obtained without the additional expense of a tail bearing. The writer has had good success with "Allan's Red Metal" as a substitute for babbitt and the tail bearing. The red-metal strips may easily be replaced after they have become worn.

The accompanying sketch is a good illustration of a case where a very serious error had been made in calculating the size of the piston rods and where the pistons were of very poor design for taking care of the deflection of the rods.

This engine is a 26 and 52 by 48-inch, cross-compound Corliss, direct-connected to an electric generator, and making 800 feet piston speed under steam at 160 pounds pressure.



POORLY DESIGNED PISTON AND TAIL RODS

The high- and low-pressure pistons weigh approximately 800 and 3000 pounds, respectively, and their rods weigh about 1150 and 2000 pounds. By applying a simple formula, the deflection of the high-pressure rod will be found to be about ⅛ inch and that of the low-pressure rod to be slightly greater than ⅛ inch.

The construction of the piston is shown in the figure. The ring is kept tight against the cylinder wall by flat steel springs, the springs being kept in place by lugs on the ring. These lugs on the ring were too long at first and consequently when deflection of the rod took place the load was carried by the ring which was only 1¼ inches wide. The result was, the cylinders were badly scored and worn in a very short time. These pistons were shipped back to the builder, the lugs on rings cut down somewhat, and the pistons and followers babbitted, the babbitt being allowed to come flush with the rings.

W. B. HAMILTON.

Ruston, La.

Makeshift Punch for Soft Materials

A few years ago I had occasion to put a cover on a small gas-engine cylinder, so as to make a pressure-tight joint between the combustion chamber and the water jacket. The only material available was a sheet of millboard asbestos about ⅛ inch thick. We could find nothing in the line of a hollow punch or gouge with which to cut the asbestos to fit over the studs holding the cover on the engine. So I took a piece of sheet tin and cutting off a strip rather more than ⅛ inch wide and carefully flattening same, made a circle the exact diameter of the outside edge of the cover. Then with six short pieces of the same width I made as many circles, each slightly larger than the diameter of the studs. After spotting the stud holes, I laid the asbestos on a table and drove in the pieces of tin. They made clean cuts and did not disturb the fiber of the asbestos. After soaking the gasket in boiled linseed oil I put it in place and made a good tight joint.

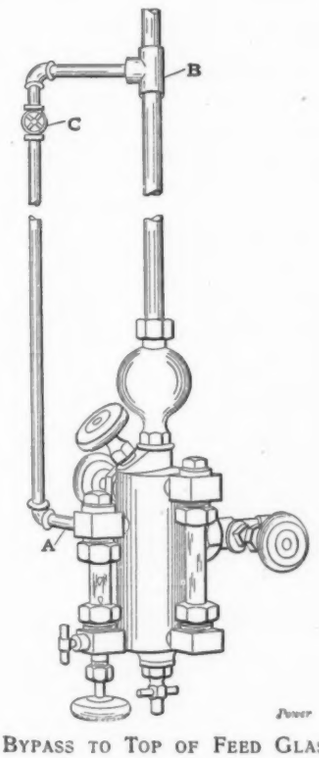
I have since used this same method for cutting various soft materials such as cardboard, leather, rubber and cork and have had good success in every case. It is essential that the strip of tin be well flattened and straight before it is bent into the required shape.

GRAHAM J. C. PARKER.

Glasgow, Scotland.

Arrangement for Keeping Lubricator Warm

This is the time of year when many engineers have trouble with lubricators not feeding regularly and the sight-feed glass filling up with oil. This is generally caused by the engine room being too cool. I have had a good deal of trouble along this line myself and the figure illustrates a remedy which has given me good results. I connected an ⅛-inch pipe into the sight-feed glass fitting at *A* and into the condensing pipe at *B*, about 18 inches above the lubricator. The ⅛-inch pipe has a valve at



BYPASS TO TOP OF FEED GLASS

C for closing it off in warm weather or when filling the lubricator.

The condensed water runs down the bypass and keeps the oil in the pipe leading to the steam line warm and moving.

GEOGRE W. SHILLING.

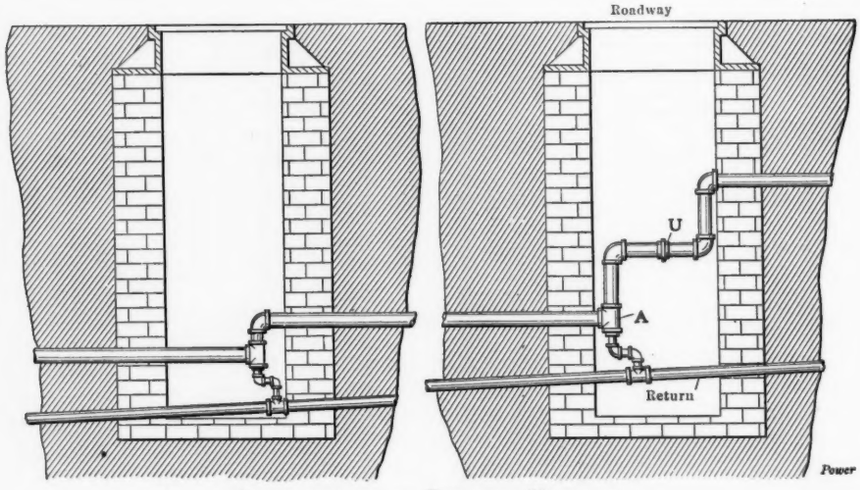
Massilon, O.

What Causes the Fittings to Break?

The steam-heating plant is located in another building about 300 feet from the house it heats. The pipes are run about 8 feet underground and pass through two manholes as shown in the figure. The supply line is drained into the return at each manhole. At this period of each year we are greatly bothered by the breaking of fittings in the supply line. I believe the breaks are due to the condition of the line. The pipes are old and so rusted at the joints that they cannot take up the expansion, consequently they must let go at the weakest points.

This year, the tee at *A* broke. When I first noticed the break the steam was on and only a hair crack was visible. After I shut off steam the crack opened up a half inch. I was unable to pry the crack closed, but when I turned steam on again, it went back itself.

In order to put in a new tee, I had to locate a union at *U*. I recommended the use of an expansion joint. The boss called in a plumber to look at the break and give an opinion. The latter said that the break was not due to expansion at all, but was the result of a steam roller passing over the road above. He said that the expansion joint would be of no special help to the pipes as there was enough give in them to take care of all expansion.



ARRANGEMENT OF PIPES IN MANHOLES

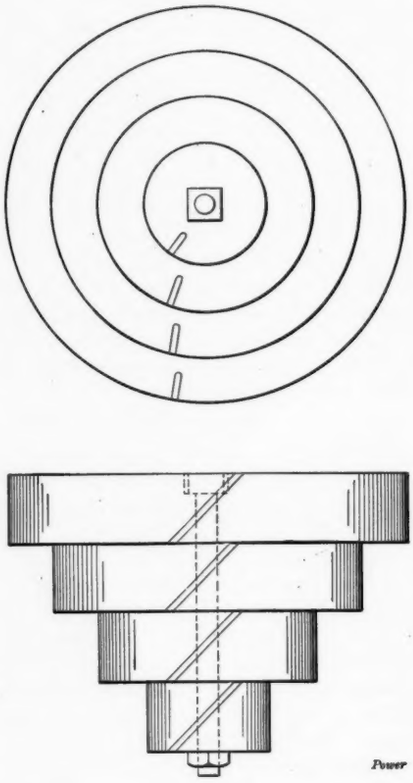
I would like to have the opinions of POWER readers as to the cause of the break and the proper remedy.

S. D. SEELEY.

Dubuque, Ia.

Convenient Packing Templets

We cut our pump packing ourselves. We find templets, gotten up in the manner shown in the figure, to be very convenient. They are made of hard wood, 1½ inches thick. Templets for one or two pumps are kept on each bolt.



TEMPLETS FOR RODS OF VARIOUS DIAMETERS

By having templets on hand, we can cut our new packing before we shut down to replace the old and do not have to work hastily or in the dirt at the pump.

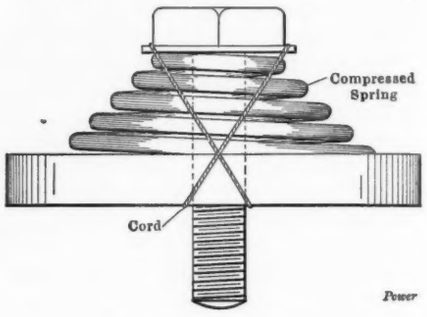
O. E. LONGBOAT.

Newark, O.

Putting in Pump Valves

It is often found difficult to get the water valve, spring and stud in place in many of the triple and duplex types of pumps, on account of their location. A method for doing this is shown in the illustration.

It is accomplished by compressing the spring and securing it in that position by winding a cord over the washer part of the stud and under the valve. When the stud has been screwed into the hole in the valve seat the cord is cut and removed, which releases the spring and allows it to exert its pressure against the valve disk and stud.



SPRING COMPRESSED

JAMES G. SHERIDAN.

Brooklyn, N. Y.

A Thump Removed

I once had charge of an automatic 12x 12-inch high-speed engine direct-connected to a generator. It had a shaft governor and piston valve, and ran 300 revolutions per minute. Upon examining the different light and dark corners of the rooms, I came across a broken piston. Searching further brought to light two piston rods, both broken at the head end, where the thread ends. Water? I made up my mind that this engine was subject to such fits. Accordingly I overhauled the drips and examined the diaphragms. In a few days I had the engine fixed up so as to please me; all of the joints were taken up and splash lubrication renewed, but when I thought I was through a thump in the head end that I noticed the first day, was there still; faint sometimes, hard for a few strokes then faint again, then nothing for a few minutes. In the boilers, the water was decently low, but to make sure I let it go still lower but the thump was there yet. Opening the separator and cylinder drips, only dry steam came from them. I went over everything again, resetting the valve, opening the cylinder, etc.; all seemed perfect—I was afraid of the heavy-load period, but it was then that the thump ceased and the engine ran so smoothly that all one

could hear was the swish of the steam through the pipes.

The man who had charge of erecting the engine came one evening and when he heard I adjusted the valve, he gradually slowed down the engine until the lights dimmed. He listened to the cut-off, accentuated because of the partially closed valve, and pronounced it O. K., looked around and finally stopped at the polished steel strap which hides the joint between the engine frame and the cylinder. He looked and pointing to the strap asked me if I saw anything there. I did see then! The joint was winking. The reason for this flashed to my mind. Water? The doses which broke the rods and the piston had strained the frame bolts, and the overhung cylinder was working up and down. When the bolts were taken up, the thump disappeared.

ALEX DOLPHIN.

Jamaica, N. Y.

Firing Classified

Assuming soft-coal fuel, good draft and boilers worked to capacity, some methods of firing may be labeled as follows:

Dead-plate firing—Coal banked on the dead plate burns out the door linings, cheek plates, etc.; the flames obscure the surface of the fire, making it impossible to cover the fire intelligently and evenly.

Blind firing—Heaving the coal through the furnace door regardless of where it lands.

Weary firing—Leaving the furnace door open longer than necessary and slow shoveling. The fireman's painful movements seem to indicate a medical examination and surgical operation are necessary.

Gage firing—Waiting for the steam to drop before covering fires instead of covering immediately before maximum heat is gone.

Tea-kettle firing—Firing too thin; cold air prevents fires from reaching maximum temperature.

Blanket firing—Firing too thick; sufficient air cannot get through to burn fire up to maximum temperature.

Front firing—Too much air going through back of grates.

Center firing—Too much air going through sides.

Come-again firing—Doors not closed tightly; air leaks.

Fancy firing—Scattering coal too much instead of covering only part of the fire at a time with each shovelfull.

Backache firing—Unnecessary poking and stirring of fire.

Absent treatment—When the fireman does not show up.

Plain firing—When the boss gets mad.

GEORGE WOOLAVER.

West Groton, Mass.

Receiver Pressure in Compound Engines

If one were being examined on compound engines, to get a license, the questions and answers would be something as follows:

Q. What is the measure of economy in a compound engine?

A. The terminal pressure in the low-pressure cylinder.

Q. What should be the receiver pressure?

A. It should be such that the fall of temperature will be equal in each cylinder.

Q. Why?

A. To reduce cylinder condensation. The economy of the compound engine results from reducing cylinder condensation and to reduce it to the lowest point the reduction of temperature should be the same, or equally divided in both cylinders.

Q. What causes cylinder condensation?

A. Exposure of the walls of the cylinder to exhaust pressure and reëvaporation of the moisture in the cylinder, both of which take heat from the cylinder walls and results in a large amount of condensation in heating up the cylinder again.

Some of us who have tried the thing out know that most of the above is principally moonshine.

If we should attempt to cool off a boiler furnace by leaving the furnace doors all closed tight with no possibility of a circulation of air and open the rear door for a second, how much would we lower the temperature?

This is similar to what occurs in a steam cylinder. The exhaust valve is open for about that interval but the cylinder is not exposed to the temperature of the exhaust pipe any more than the furnace is exposed to the temperature of the surrounding air by opening the rear door.

We have learned that the economy of a compound engine is the highest when the governor revolves in its highest plane and this occurs usually when the receiver pressure is the lowest, regardless of whether the fall in temperature is the same in both cylinders or not.

Work performed in a steam cylinder takes out a small amount of heat and condensation is the result.

Is it true that its reëvaporation takes heat from the cylinder walls?

If we throttle steam in a pipe we do not claim that the expansion of steam and reduction of pressure condense the steam. We claim that it still contains the total temperature and the result is a drying and a superheating of the steam. When steam is expanded in a cylinder it does not condense; it follows the same law as though expanded in a steam pipe.

If expanding in a steam pipe superheats the steam, why is it not just as reasonable to conclude that expanding in a cylinder superheats it; neglecting the small amount of heat consumed in performing work, and is it not this very dry, or superheated steam, that reëvaporates the moisture rather than the cylinder walls?

If we carry a low receiver pressure we reduce the terminal pressure in the high-pressure cylinder as we cut off shorter and the weight of steam at terminal will be reduced and a less weight of steam delivered to the low pressure so that the higher terminal at low pressure does not mean a greater weight per horsepower.

In a recent issue I told the story of putting in a 15x24x42 engine to take 25 per cent. of the steam from the receiver in summer and run condensing and suggested that a later trial would determine the most economical receiver pressure.

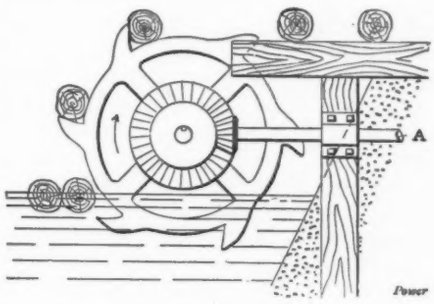
In this case it proved to be a pressure not exceeding 2 pounds.

W. E. CRANE.

Broadalbin, N. Y.

Raising Logs over Dam

An ingenious way of raising logs over a dam is shown in the figure. Power is transmitted from the mill to the big



WHEEL FOR LIFTING LOGS

wheel by means of the shaft *A* and the miter gears. The logs are floated up to the lower side of the wheel, caught on the hooks and thrown over onto the skids.

T. A. KNOWLTON.

Conway, N. H.

A few drops of water trickling on a bearing will often make it run cool where no amount of oil will help. There are a number of makeshift methods for applying the water. Fasten a hose above the bearing and allow the water to drip slowly; or, fasten an ice-water tank above it and regulate the stream with the valve. Another way is to tie a pail of water above the bearing and dip a siphon made out of a short piece of hose into it. The water can be controlled by inserting a plug in the passage.

SUBJECTS UNDER DISCUSSION

Comment, criticism and debate upon various articles, letters and editorials which have appeared in previous issues

Pound in an Engine

Speaking of Le Roy Scott's trouble, and having read in POWER of what might cause the pound, I will state a little experience I had with an engine, and although it is a small affair, 12x18, I have often wondered how so small a thing could make so large a noise. Sometimes the pound seemed to be in the crosshead, then it would appear to be in the crank pin; the throwing on of the different machines in the factory would throw the pound into the cylinder. The boxes would not stand any more keying. There seemed to be a hard knock on each end of the stroke, more so, as Mr. Scott says, on shutting down on account of not having any steam to cushion on. Night after night I worked filing brasses, shimming up driving keys and scraping boxes, all to no purpose. The engine would run all right at night, but when the load went on in the morning it would start on its merry pound again.

I thought several times that the crank pin was out of round. I entertained the idea for a while that she was out of line. I also thought there was too much clearance space between the boxes and pin, allowing it to side slap. I took shims out from under the slide plates, but this made it worse. At last I found my trouble in a funny way. In shutting down one night she stopped on dead center. In throwing her off I noticed the crosshead moved but the shoe did not. The crosshead is set into a babbitt shoe and had worked loose, allowing it to go and come. When on the outward throw the crack, of course, would be closed so you could not see it, and when on the other end the guide plates would cover it. I removed the shims under the slide plates, turned her over on the dead center, then screwed the plates down tight on the shoe and by turning the flywheel opened up the crack, filled it with hot babbitt, put the shims back under the plates and the engine is now running perfectly.

E. F. LANDON.

Charlestown, N. H.

In the November 23 issue, B. E. Charles discusses the cause of a pound in Le Roy Scott's engine. He believes the knock is caused by too much play between the guides and crosshead and by the fact that the engine is running under.

My experience does not bear out the statement by Mr. Charles, that "the pressure of the crosshead is always against the upper guide" on an engine running under. Instead, I have always experienced a great deal of trouble in preventing my engine, when running under, from pounding as it goes over the centers. He shows clearly by his diagrams and discussion, how the connecting rod gives an upward thrust on both strokes, but he fails to explain what prevents the crosshead from being drawn by gravity to the lower guide as the crank passes the centers.

In automatic engines I have always experienced more or less pounding in the governor as the engine is brought up to speed, and again as it slows down after closing the throttle. I am of the opinion that Le Roy Scott's trouble was located at that place.

As this trouble has been thoroughly discussed, I suggest that Mr. Scott inform us where he really did locate the trouble.

J. M. ROW.

Fort Monroe, Va.

Flue Areas

When a new boiler arrives it is often up to the engineer to have the connection made with the stack; hence, an article like the one by E. J. Terman on "Proper Area for Boiler Breechings," which appeared in a recent issue of POWER, cannot fail to be of interest. I do not agree with the author's statement that the capacity of a horizontal or vertical tubular boiler varies almost directly with the length of the tubes for any fixed diameter of boiler, and I do not think we can go by the cross-sectional area of the tubes in determining the proper area of the breeching. The tube surface ordinarily represents from 85 to 90 per cent. of the total heating surface of the boiler and it would be interesting to know how many square feet of surface Mr. Terman allows per boiler horsepower in order to get the effect stated.

In the November 30 issue is a very interesting article by F. W. Dean on a vertical fire-tube boiler having about 4900 square feet of water-heating surface, 1811 square feet of superheating surface and rated at 500 horsepower. This is on a basis of about 10 square feet per horsepower, an ordinary rating for this type of boiler. By artificial draft, the capacity of this boiler was increased to 1100 horsepower, or one horsepower for each 4½ square feet of water-heating surface, and what is still more notable, without increasing the degree of superheat which shows beyond doubt that the maximum capacity of the boiler had not been reached. The above is only one of many practical demonstrations that the most effective heating surface is in the first few feet of flues nearest the firebox.

Suppose doubling the length of the flues doubled the capacity of the boiler, why should it not be proper to base the area of breeching on the cross-sectional area of flues. In place of a 10-foot boiler of, say, 50 horsepower, we put in a 20-foot one with the same diameter and number of flues. To get 100 horsepower out of this boiler we must evidently burn twice the amount of coal which means of course at least twice the amount of gas. This increased volume of gas must pass through the same limited flue space in the boiler so we must increase the draft and give the gases higher velocity. If the area of the breeching in the original arrangement was based on the combined area of the flues, what good would it do to increase the breeching to nearly double the area as given in the tables accompanying Mr. Terman's article? The draft has been increased to give the gas sufficient velocity to pass through the restricted passages in the boiler. They will find easy travel on reaching the one big passage in the breeching at this increased velocity. On the other hand, suppose we double our boiler capacity by increasing the diameter of the shell and the number of flues and by building a correspondingly large firebox, we can burn more coal without any particular change in draft, providing, of course, that the stack is large enough to handle the larger volume of gas. A breeching based on the increased cross-sectional area of flues will have the required area. In either case, it seems to the writer that it is not only logical but more practical to base the area of the uptake and breeching on the cross-sectional area of the flues.

R. CEDERBLOM.

Gary, Ind.

The Salesman and the Assistant Engineer

The story about Uncle Pegleg and the drummer that appeared in the November 23 issue was certainly very interesting. The type of salesman, whose character was so ably drawn, is regrettably com-

mon. The following are two examples of the lack of tact common to these gentlemen, who are supposed to possess this quality in a high degree:

At a certain electric-light station, the chief had stepped out on business and the assistant engineer had hustled with his duties so as to get time to glance over the headlines of the newspaper. Just as he was wiping his hands in comes a drummer who inquires for the chief. When informed that he is not expected to return for an hour, the salesman doffs his overcoat, picks up the paper, and removing the outer sheet with which he covers carefully the seat of the chair, sits down to read the remainder of the very paper the assistant is so anxious to glance at. It must not be inferred that the assistant lacked courtesy. He would willingly have forgone the pleasure of scanning the paper to make his visitor comfortable. What rankled, was the fact that the drummer's own paper stuck out of his overcoat pocket; and that the assistant was not considered of sufficient importance even to pass the time of day with. This was the only chance that drummer had of making friends with the assistant, for the chief happened to be present every time that he called thereafter. A year later, a fine new factory was erected in town, and the assistant secured the position of chief engineer. The fact was duly communicated to the drummer, and with a glad smile of anticipation he hustled over to see the new chief. Did he do any business with him? Oh, yes!

At a certain other station, the chief and the assistant were having a pleasant chat, when in marches a packing salesman. After a seemingly hearty handshake with the chief, the drummer remarks:

"Chief, you are getting black in the face from smoking that pipe. Try this."

The proffered cigar is accepted and with evident meaning the chief replies:

"This is Tom, my assistant."

A cold 'How do you do' follows and Tom, feeling like 30 cents, moves away muttering to himself: "He might have had the tact to wait till I had gotten out of the way before passing the cigars."

This salesman represented a mediocre grade of packing. It seems curious that the first lot tried should have given such good results. The second batch was so poor that the chief was obliged to stop trading with that drummer. Every practical engineer will at once know the reason why, but for the edification of such drummers as may read this, it probably will not be amiss to call their attention to a few points.

Don't forget that while it is the chief engineer that gives you the order, it is the assistant that uses the packing, and surely, even you know that the method of applying the packing has very much to do with its success.

A few pleasant words with the assistant cost nothing, and if you have not enough cigars to pass around, wait until you are alone with the chief.

Don't forget that the present assistant engineers are the future chiefs.

Beware of blunders of speech such as one salesman made when I asked him to supply me with a well graphited packing.

"Oh, you'll find our packing well graphited," he assured me, "we use plenty of graphite to add weight."

L. M. LESLIE.

Cambridge, Mass.

Compression Outside of the Main Cylinder

In the November 30 number Mr. Kirlin among other things has this to say: "There is a considerable number of engineers who do not agree that compression of any kind is necessary in the case of slow- or medium-speed engines, and it must be admitted that they seem to be getting along very well without it too." I will admit that they may seem to get along very well, but I will not admit that they get along as well as they should. In my mind there can be no question but that every engine given approximately the right amount of compression, will run with less noise, more economy and less wear and tear than it will with no compression. In starting from dead center the reciprocating parts absorb a certain amount of energy which is again given up when the parts are brought to rest at the end of the stroke; it is evident that but little of this energy can be transmitted to the flywheel, or in other words, used up in turning the shaft on account of the position of the crank. Therefore, most of it is absorbed by the pins and main bearing and causes increased friction and heating. To overcome this additional friction more of the energy stored in the flywheel is used up to bring the engine past the center. But, on the other hand, if our engine had compression the energy given up by the reciprocating parts would be absorbed by the steam and turned to useful work on the return stroke. The correct amount of compression is that which produces the quietest running.

CHARLES L. ANDERSON.

East Chicago, Ind.

Position of Throttle

I do not agree with W. E. Crane that the throttle wheel should be placed over the back cylinder head. Standing in front of the cylinder head is not the safest place for a man to be when starting an engine. Besides, when starting a Corliss engine, the engineer must be on the valve-gear side in order to adjust the dashpots and see that the valve mechanism is working properly.

It is always necessary to have the wheel a little loose on the valve stem so that you can open the valve slowly and close tightly without injuring either seat or valve. Whenever it becomes necessary to use a starting bar to open a throttle valve or to close it so that it will not leak, the valve should be taken apart and repaired.

OAKES KYGER.

Danville, Ill.

Emptying Oil Barrels

E. L. Griggs' article on emptying oil barrels in the December 7 issue of POWER reminds me of a similar scheme which I once saw tried. There was no crane or tackle near the oil tank and it was desired to put a barrelful of oil into the tank quickly and easily. A scheme similar to Mr. Griggs' was successfully tried a number of times. The difference lay in the fact that instead of water, air was used from the air line which usually carried about 60 pounds pressure. The barrel was laid on its side and a pipe run from the lowest point in the head, up and into the tank, the air hose connected to the bung hole and air admitted so as to maintain a few pounds pressure in the barrel. One day when it was found necessary to refill the tank, a barrel of oil was brought in and the usual connections made. The man holding the hose against the bung hole asked another man, who had not seen the operation performed, if he would turn on the air at the other end of the hose. I was at the other end of the room and the first thing I heard was a crackling, bursting sound and a piece of barrel head enveloped in oil flew by me. It is easy to guess what had happened; there was oil everywhere, and it is hardly necessary to describe the condition of the man at the barrel. Of course the cock had been opened too wide and more air pressure had been put on the barrel than it could stand. The scheme is all right, however, and has an advantage over Mr. Griggs' idea, if air pressure is available, in that you don't have the barrel left full of water. But you must take great care to "turn her on easy."

O. W. MIDDLETON.

Chicago, Ill.

Fuel Oil

For some time past articles have appeared in this journal on coal analysis, giving the B.t.u., volatile matter, percentage of water, ash, sulphur, etc.

I have not seen one line on the subject of fuel-oil analysis, except the data given out some years ago by the Government experts, and those data were complete only from the viewpoint of the adaptability of the best kind of burner for marine practice, which is of but little value to operating engineers in stationary practice.

I, for one, and I believe the majority of engineers who are operating oil-burning plants, would like to see some tests made, and analysis of fuel oils, as to the B.t.u., C, N and H_2O, also the per cent. of CO and CO_2 content in flue-gas analysis of fuel oils, as well as the number of pounds of water one pound of oil will evaporate, specifying the different grades of oil in degrees Baumé.

Also the most modern and economical way of constructing boiler furnaces, also burners, as well as the best method of applying the oil to the burner in the furnace.

No one man knows it all, but I am of the opinion that there are some of the engineering fraternity who have some part of these data. I suggest that each engineer send in his mite of information for publication.

I also make an appeal to all engineers, prominent, or otherwise, who have the facilities for making such tests, or who have made tests, or have the time and apparatus for making such analysis, to do so, and let those of us who have no means of getting this information know about these matters.

I believe that every engineer who is using oil for fuel can persuade his employers to coöperate with him to the extent of buying a few necessary instruments to the desired end; for instance, a Baumé hydrometer for getting the gravity of the oil used, which also serves as a check on dealers from palming off an inferior grade of oil; a 500- or 600-degree thermometer, Fahrenheit, for finding flash and burning point; also a glass test tube, the whole costing but a few dollars, and paying for themselves in a very short time.

P. J. BRANT.

Fruitvale, Cal.

Proper Amount of Lead

The idea that late admission may result in economy is, to say the least, without support from those who ought to know, and whom I really believe do know.

The measure of efficiency of any heat motor is the heat utilized in the development of power, and the greater the range between the initial and terminal temperatures, the greater the efficiency, that is, the greater the per cent. of heat utilized. This holds good up to the point where the loss due to initial condensation balances the gain due to high initial pressure and short cutoff. In an engine working under normal conditions, if the admission is delayed, the cutoff will be later, and the initial pressure being the same, the terminal pressure will be higher and the exhaust steam will have a higher temperature than if admission occurred at the proper moment and cutoff occurred earlier.

As for the running of the engine under the conditions described by Mr. Kirlin, will say that it has been my experience that engines do not run smoothly when valves are set as described in the discussion. I have a collection of diagrams showing something not quite so radical as the set shown by Mr. Kirlin, and the engine did not run smoothly but on the other hand performed in a manner that would make the engineer ashamed to have his friends call on him.

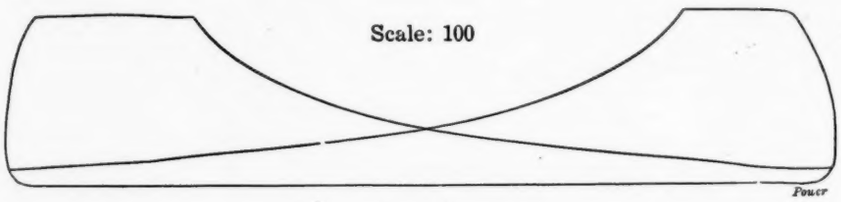


FIG. 1. LATE ADMISSION

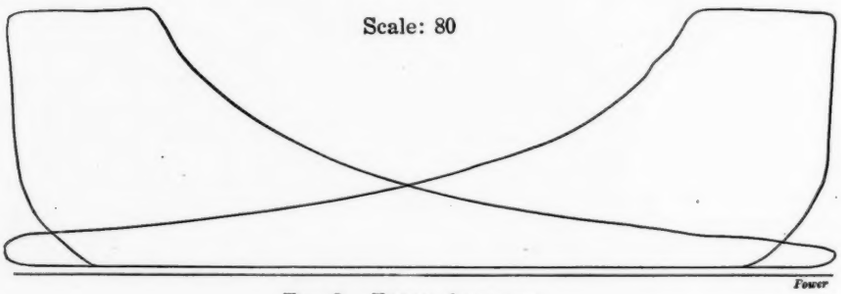


FIG. 2. EARLY ADMISSION

I indicated and adjusted this engine, and know from observation that under conditions indicated by Fig. 1, the engine groaned and pounded, and the motion was very irregular, the engine making a jump on each admission. Under the conditions exhibited by Fig. 2, the engine ran as quietly as a sewing machine, and you could hardly feel a tremor with your hand on the main bearing or frame as she passed the centers.

WILLIAM WESTERFIELD.

Lincoln, Neb.

Low Receiver Pressure

I noticed in a recent issue that our friend "Tom Sawyer" is a believer in low receiver pressure. What is low receiver pressure? "Tom" would have conferred a lasting favor upon us if he had got down to brass tacks and told us just where the dividing line between high and low receiver pressure lay. As it is he simply opened the discussion without really contributing anything to it. He ought to have suggested some definite rule by which we might be enabled to satisfy ourselves whether we were carrying high or low pressure in the receiver.

In this connection I have something in the way of low receiver pressure experience which it is "dollars to doughnuts" he has not. "Tom" may have obtained what he was satisfied to call low receiver pressure, but after seeing what I have to show him in Fig. 1, I feel sure he will yield me the palm.

FIG. 1

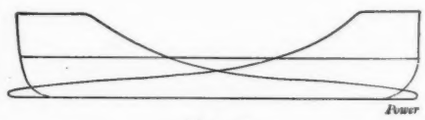


FIG. 2

The diagrams were taken from a 14 and 28 by 36 tandem-compound Corliss engine running condensing. I had previously operated this engine myself, and usually carried 145 pounds pressure in the boilers and 20 pounds in the receiver, and maintained a vacuum of 26 to 28 inches. One morning about eight o'clock I was asked to come to the plant. When I arrived, I found the low-pressure cylinder was taking steam almost full stroke, and the receiver gage showed about 30 pounds pressure. On this engine, the cutoff on the high- and low-pressure cylinders was adjusted independently by means of a set screw. The valves were double ported and the travel was very short even on the heaviest loads. It is evident from what

followed that the engineer had changed the adjustment of the valves on the high-pressure cylinder. He must have started to give the engine steam without hooking up the proper valve on the low-pressure cylinder, and as a consequence the receiver was charged up almost to boiler pressure. The receiver relief valve probably stuck. When it did let go it blew dirt and mud from the receiver pit all over the engine room. The receiver gage had a range of 50 pounds. The pressure running up to about 140 pounds distorted the spring so that "after the show was over," the gage registered about 20 pounds with no steam in the receiver. A little thing like that did not disturb the engineer; he essayed another trial, and she went. She also made the firemen go; she developed an appetite for steam that was scandalous.

When I went in and looked around, I thought I knew where the trouble lay, but determined not to lose the opportunity to get a freak diagram. A copy of the diagram is shown in Fig. 1.

After I had adjusted the cutoff on the low-pressure cylinder and set the valves on the high-pressure cylinder, the engine got back to business. Fig. 2 shows a diagram from the low-pressure cylinder after adjustments were completed.

WILLIAM WESTERFIELD.

Lincoln, Neb.

Receiver Pressure

In the November 2 number, E. A. Baldwin tells of a problem he has encountered, and asks for assistance. He states that when he tries to put more load on the low-pressure side of a cross-compound Corliss, by raising the receiver pressure above 10 pounds, instead of taking load off the high-pressure side, it has the opposite effect. From this I judge the engine is very light loaded and the low-pressure cutoff is not controlled by the governor, but is adjusted by hand although this is unusual in a cross-compound Corliss. If I am correct in my supposition, when the already short cutoff on the low-pressure side is still further shortened the valve does not open wide enough to allow the steam to pass into the cylinder; the result is that while the receiver pressure, and consequently the back pressure on the high-pressure side is raised, the initial pressure in the low-pressure cylinder is not raised correspondingly. Little work being done in this cylinder, the engine slows down, thereby lengthening the cutoff on the high side. But as Mr. Baldwin does not say anything about the engine racing I take it that the governor does not control the low-pressure cutoff. Of course raising the receiver pressure by admitting steam from some outside source does not restrict the port opening, therefore, the initial pressure in the low cylinder is raised and the engine speeded up, causing a shorter cutoff in the high-pressure cylinder.

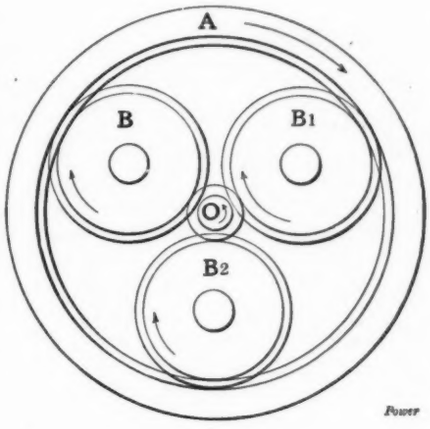
CHARLES L. ANDERSON.

East Chicago, Ind.

Simple Gear Pinion Arrangement

Although theoretically there is no limit to the amount of power which a simple gear-pinion arrangement can transmit it is evident that in big installations some means should be employed to balance some of the stresses which begin to assume large proportions as the power transmitted increases.

In a general way the greatest strain which an ordinary spur gear-pinion combination is subjected to is the tendency of the gears to push away from each other and permit the rotation of one without movement of the other; this is



SPEED-REDUCING GEAR

of course taken care of by the bearings. It would be better if means could be employed to have this thrust split up and applied at opposite points on the driving gear, thus balancing one part against the other.

A glance at the accompanying sketch will make the idea clear. *A* is a large internal gear mounted on the reduced-speed shaft. *B*, B_1 and B_2 are intermediate gears mounted on a stationary spider, omitted for the sake of clearness. *O* is the pinion rigidly fastened to the high-speed shaft.

A brief inspection will reveal that:

There are three times as many teeth in contact with the pinion as there are in the customary gear-pinion arrangement.

That the forces tending to thrust the gears apart are balanced.

That the driven shaft and the driving shaft have a common axis, a feature not embodied in the Melville-Macalpine nor any similarly constructed gear.

WESLEY MCARDELL.

Brooklyn, N. Y.

Writing for Catalogs

It is well known that trade catalogs furnish an abundance of useful information which most any progressive engineer is glad to get, and as they are often easily obtained, there seems to be a strong tendency on the part of engineers to write for the more desirable ones, frequently without inclosing the necessary postage. Now is this fair to the people who issue these catalogs, often at great expense, in anticipation of trade?

I have been guilty of the offense myself, but repented long ago, and now when I wish a catalog, I inclose a sum of money which I think should cover the cost together with the postage, stating that I am an engineer and want the same for my own instruction. If it is worth having at all, it is worth paying a little something for, especially when it is myself who is to be benefited. This method does away with annoying letters and does not leave one in a false position.

I had occasion some time ago to write for a large engine-building company's catalog. In due time I received it with a courteous letter, returning the money which I had sent. It has never yet been my pleasure to turn any business their way, but should opportunity ever present itself, their kindness will be remembered.

H. M. WINSLOW.

Cumberland Mills, Me.

I think this subject has some sides which have not been touched upon in any of the discussions that have come under my observation.

An ambitious fireman writes to a firm making power-plant equipment. There are firms short sighted enough not to understand that this fireman is going to be an engineer some day, and as such will advise in the purchase of power-plant apparatus. But most firms understand that the fireman who is ambitious enough to seek information in this manner is going to be the man in the future whose advice will influence the action of the employer in the solution of problems arising in the power plant. I think the wise builder and manufacturer will give those ambitious enough to inquire about their machinery or apparatus, the information they seek, for while results may not be immediate, they are none the less sure.

I have had the advantage of observing a great many men who seek information in this way, and from this I can say that I do not believe there is as much as 1 per cent. of the men in subordinate positions who write for catalogs who do so from any other motive than to secure for future use in a legitimate manner, information pertaining to equipment of which they one day hope to have charge.

In my opinion, furnishing catalogs to

those who are ambitious enough to ask for them is the easiest and cheapest way for manufacturers of power-plant apparatus to coöperate with the men who are now, or who later will be handling apparatus such as they supply. The study of catalogs is an excellent aid to self-education. The man who has made himself familiar with any machine or appliance through careful study of the manufacturer's description of it should be able to get better results from it than the man who has not. In this manner, the firms that send out literature are helped by so doing.

In conclusion, for the benefit of the manufacturers, I wish to say that the men who write for literature are not likely to be curiosity seekers. Any man who earns his living by standing in front of a battery of boilers feeding coal to their hungry furnaces has something more on his mind than idle curiosity when he writes for catalogs. Ninety-nine times in a hundred he is looking up, and when a man is looking up, it is dollars to doughnuts that he will get up. So keep the catalogs coming. Don't be afraid to do a little sowing now, for if you have a good thing, the time of reaping will come. I know whereof I speak.

WILLIAM WESTERFIELD.

Lincoln, Neb.

Experiences of a "Trouble Man"

Referring to the article under the above caption by William Westerfield in the December 21, 1909, number, the writer cannot understand how it is possible to have the high-pressure exhaust valves open at the time shown by the diagram and close promptly. On looking over the low-pressure diagrams shown, I fail to see any signs of excess pressure which ought to be present in this case. Neither do the diagrams taken after adjustment show any appreciable gain in efficiency. The low-pressure side is more evenly balanced and the compression is reduced, both of which, in my opinion, are improvements, but the vacuum shown on these diagrams is less than before adjustment. When I get diagrams like these, which I have more than once, I look for the fault in the indicator piston, as it evidently sticks at this point, and is probably responsible for the perfect steam line and the sharp cutoff shown, which the writer has never been able to get except under these conditions.

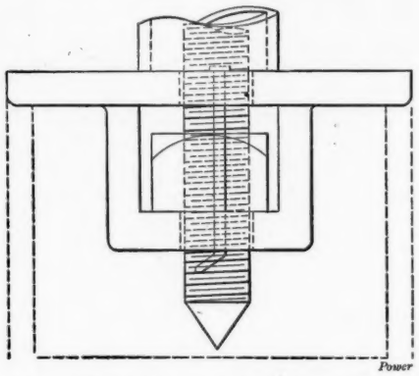
However, as Mr. Westerfield succeeded in effecting a marked improvement in the running conditions, and a noticeable improvement in economy, no doubt all concerned are happy.

J. W. FOWLER.

Richard City, Tenn.

Foundation Bolts

The arrangement of foundation bolts shown by Howard M. Nichols in the November 23 number of POWER would no doubt be good for small foundations which are above the floor, but would be bad practice, as Mr. Nichols states, for large foundations. The accompanying sketch shows a style of washer which I have seen used and proven satisfactory. Of course the size of the washer depends on the size of the foundation bolt



CAST WASHER WITH RECEPTACLE FOR NUT

being used. It will be noticed that the bolt is pointed on one end; this makes it self-centering, shifting the nut in the washer to suit. The bolts are hung in templets, and a wooden box placed under the washer. A pipe of proper size is slipped over the bolt, leaving it free. This makes adjustment or removal very easy.

F. W. BELLINGER.

Havre, Mont.

Cement Testing Needles

A note in the October 26, 1909, issue states that a needle weighing 2½ pounds with a point 1/16 inch square is used for determining the setting time of cement. There is no adequate authority for the dimensions given, and although they might answer well enough if adopted by common consent, this is not advisable as there is already an established standard. In fact, there are two standards which are supplementary. The first is a weight of one-fourth pound with a flat point 1/12 inch in diameter, and the second is a weight of one pound with a 1/24-inch point. The lighter needle is used to determine "initial set," and the heavier to determine "final set." In practice about one-fourth pound of cement is mixed with 20 to 25 per cent., by weight, of water and molded into a round flattened cake on a glass plate or other nonabsorbent surface. The two setting times are the intervals which elapse from the minute water is added to the cement until the cake supports each needle without indentation. The standard specifications in use in this country for testing portland cement provide that initial set shall not occur in less than one-half hour and final set in not more than 10 hours. The results are largely relative, being affected by numerous conditions, and two independent trials may not check within 10 per cent. The quantity of mixing water used, amount of kneading of the paste and the humidity of the air all affect the result. The needles described are not new but were used prior to 1830 by General Totten, U. S. A. Subsequently they were adopted by General Gillmore in his noteworthy investigation of cements and have come to bear his name.

A. S. MERRILL.

Oak Park, Ill.

Direction of Lap in Stack Joints

In the issue of December 14, 1909, Charles H. Parsons takes exception to W. N. Zurfluh's suggestion to make the joints in steel and iron stacks the reverse of the old practice.

I advocate the reversed joint, and have been using it for 20 years at least, and am led to believe it good practice from observing the dozens of stacks we have throughout the country that show rust streaks running from the joints half way down the sheets. And I notice that these streaks always start at the joints.

Well puttied and painted stacks do not have these streaks. They are caused by water on the inside of the stack taking up sulphuric acid from the soot, and leaking through the joints; the acid soon destroys the paint and rusting sets in.

More fully to prevent this, our latest stacks are made with what Mr. Parsons, no doubt, would call a worse arrangement; a lip is turned in at the bottom edge of the three or four upper sheets, so as to prevent the possibility of the acid water being drawn up into the joint by capilliary action.

One would think these lips would interfere with the draft, but as a matter of fact, we cannot see that they do. This is probably due to the same reason that a diaphragm with a hole half the area of the pipe, put in a steam pipe, will not interfere with the flow or pressure of the steam to any extent that can be detected by ordinary instruments.

We have the sections made parallel, which gives the stack taper enough to prevent its looking the largest at the top.

JOHN E. SWEET.

Syracuse, N. Y.

To make a file take hold better, dip it occasionally in gasolene. Have a bottle full of the liquid handy, but always keep it corked to prevent its rapid evaporation.

Effect of Superheated Steam on Cast Iron

Discussion of the Papers Presented by Professors Hollis and Miller and Arthur S. Mann before the American Society of Mechanical Engineers at Boston, Mass.

The discussion commenced with the presentation by Prof. H. F. Rugan, of the Tulane University of Louisiana, of a synopsis of a paper read by himself and Prof. H. C. H. Carpenter, in the fall of 1907 before the Iron and Steel Institute at London. Experiments to determine the time to produce growth in cast iron developed the fact that a change in the temperature of the samples was necessary to produce growth, no apparent difference in growth being observed between samples heated for a period of three to seventeen years. Experiments were made with nine iron-carbon alloys containing no graphite, the carbon ranging from 4.03 to 0.15 per cent. Other constituents were low and constant. No growth was observed in any save the sample which contained the highest percentage of carbon, and this shrank for the first twelve heats, afterward expanding and ultimately becoming 6.88 per cent. larger than its original volume.

When it was found by fracture that these were all white iron, a high-carbon medium-silicon series was cast. Of these, three were gray and one white iron. The gray irons grew from the start; the white iron followed closely the action of the first sample, first shrank and then grew to over 6 per cent. larger than the original. Analyses show that the appearance of free carbon or temper carbon coincided with heats indicating growths in the test pieces. Free carbon was in this way proved to be in some way an indispensable factor in the growth of cast iron while under heat treatment. The gray irons grew from the start and their progress indicated a close relation existing between their respective growth and their silicon content. The analyses of the alloys designed to test more specifically the part played by silicon are as follows:

PERCENTAGE.

Alloy.	Total Carbon.	Combined Carbon.	Graphite.	Silicon.	Manganese.	Sulphur.	Phosphorus.
N	3.98	0.64	3.34	1.07	0.25	0.010	0.013
O	3.98	0.68	3.30	1.79	0.23	0.010	0.013
P	3.79	0.30	0.49	2.96	0.25	0.010	0.012
Q	3.76	nil	3.76	4.20	0.27	0.010	0.012
R	3.79	nil	3.79	4.83	0.30	0.010	0.012
S	3.38	nil	3.38	6.14	0.30	0.010	0.013

It will be noticed that the quantity of silicon has progressively increased, while that of the other constituents is small and perceptibly constant.

Alloy N: Test piece cut from riser at some distance from the gate. This was an iron with a fine close grain. Under heat treatment it grew steadily and reached its maximum growth in about sixteen heats. It did not crack and retained its cylindrical form to the end.

Alloy O: Position from which the test piece was cut uncertain. Iron very similar to *N* except that the grain is coarser; slight cracks developed over the entire surface after the twelfth heat.

Alloy P: Test piece cut from the bottom of the gate. This appeared to be a very open iron, but it retained its cylindrical shape almost perfectly throughout the treatment and did not crack. It grew very rapidly at the outset; 25.2 per cent. in five heats.

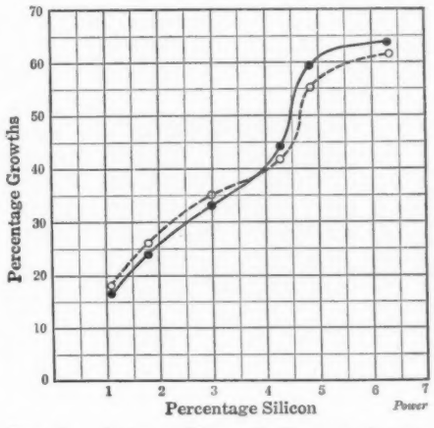


FIG. 1. ALLOYS N TO S CURVES ILLUSTRATING THE RELATION BETWEEN PERCENTAGE GROWTH AND PERCENTAGE SILICON

Alloy Q: Test piece cut from a riser. This was an open-grained iron. After the third heat it was noticed that the ends were larger than the central parts of the sample. At a later stage, however, the center caught up this increased growth. After fifty-two heats an approximate determination of the growth was obtained by measuring the circumference of the bar and making an allowance for the cracks. The results showed that very little growth had taken place after the fifteenth heat.

Alloy R: Test piece cut from a riser. This alloy was very similar in appearance to *Q* and behaved very similarly under heat treatment.

Alloy S: Test piece cut from the bottom of the gate. After the first heat a circular crack developed at one end, the outer ⅛-inch circumference cracking away from the core. After the second heat numerous cracks developed, the largest being 5/64 of an inch wide. After the sixth heat this had increased to about ¼ inch, and the sample broke in two pieces at the center after being handled. Thirty-two heats were carried through and small particles constantly disengaged themselves from the cracked surfaces, thus rendering the measurements or weight too low.

The results are summarized as follows:

Alloy.	Percentage, Silicon.	Percentage, Growth.
N	1.07	15.40
O	1.79	23.46
P	2.96	32.85
Q	4.20	43.90
R	4.83	59.50
S	6.14	63.00

It is quite clear from these tests that silicon is a most important constituent of cast iron from the standpoint of growth under repeated heatings. If the ultimate growths and percentages of silicon are plotted, the resulting curve, Fig. 1, shows that broadly speaking the growth is proportional to the percentage of silicon, although the value for *R* seems relatively higher than those of the other five alloys; the growths are far in excess of those that could be caused by conversion of combined into free carbon. The question then arose: Would an iron-silicon series containing no graphite grow on repeated heating? To settle this question three alloys with ascending silicon and as little carbon as possible were cast under similar conditions to previous alloys. The carbon was from 0.17 to 0.19 per cent. The microscopic examination showed in all three cases a solid solution of iron silicide in iron. There were no traces of graphite on any other structural constituents present. Machined bars were heated fifteen times under the same conditions as previous alloys. A summary of the final values is as follows:

Alloy.	Per Cent. Silicon.	Per Cent. Change of Volume After 15 Heats.	Per Cent. Change of Weights After 15 Heats.
T	0.65	—0.025	—0.04
U	1.10	0.000	—0.03
V	2.71	+0.394	—0.02

It will be seen that the only alloy of the three which showed any tendency to grow was *V*, with 2.71 per cent. of silicon, and compared with that of *P*, with 2.96 per cent. silicon and 3.79 per cent. car-

bon after the same number of heats its growth was almost negligible, 0.394 as compared with 31.35.

Alloys *K*, *N* and *P* correspond closely to alloys *T*, *U* and *V* in silicon content. They also contained about 3.9 per cent. of carbon mostly in the form of graphite as compared with a mean figure of 0.18 per cent. of carbon, none of which is present as graphite, in the other series. A comparison can thus be made in the changes of volume of the two series under similar tests after fifteen heats as follows:

Alloy.	Carbon.	Silicon.	Per Cent. Change of Volume.	Alloy.	Carbon.	Silicon.	Per Cent. Change of Volume.
T	0.17	0.65	—0.025	K	3.90	0.69	+ 5.40
U	0.18	1.10	0.000	N	3.98	1.07	+15.20
V	0.19	2.71	+0.394	P	3.79	2.96	+31.35

This comparison serves to emphasize anew the fact that free carbon in the form of graphite is one of the essential factors in the growth of cast irons under heat treatment. The previous series of alloys, however, brought out equally clear that in a constant-graphite series the growth is roughly proportional to the silicon present. It is clear, therefore, that both graphite and silicon are involved in these changes of volume after repeated heating. Sections of sample *P* were then examined at a magnification of 150 diameters, and Fig. 2 shows the reproductions of photomicrographs thereof. No. 1 shows the structure of the original casting. As shown by the chemical analysis, the greater part of the carbon is present as graphite (seen as black lines), the remainder of the field (mottled) shows the solid solution of iron silicide in the residue of the iron together with a small quantity of combined carbon.

No. 2 shows a boundary between a gas-penetrated area (dark) and a still unaffected part of the interior (light) in which the graphite plates and the solid solution are clearly seen.

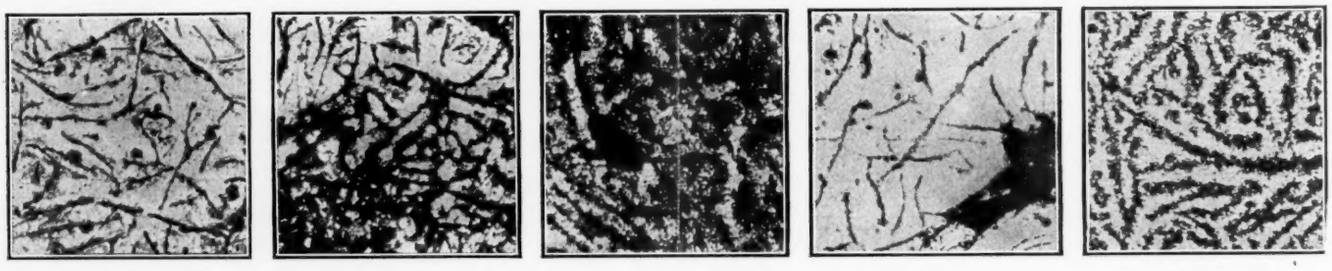
No. 3 shows a completely gas-penetrated area in the early stages (after three heats).

No. 4 shows the structure of a part of the interior to which the gas had not penetrated after three heats. It is a most interesting photograph because it throws light on changes that take place in the interior of the alloy before the gases, penetrating from the outside, have time to make their influence felt. The three large dark areas are holes, and the lines distributed through the white areas, although they doubtless correspond to original positions of graphite, no longer represent as much of it. They are for the most part slits from which the graphite plates have been removed. The agency in this removal appears to be the gas originally dissolved in the metal which is probably liberated by heating at the surface of the solid solution in contact with the graphite. The latter is much the weakest mechanical constituent and appears to be forced into holes originally present in the casting which may be and doubtless are enlarged by the breaking down of the boundaries between two holes when these also consist of graphite.

No. 5 is typical of the structure of the alloy after maximum growth has been reached. It bears a distinct resemblance to No. 1 in general character with one important difference, this that graphite has vanished from its original position in the form of plates, and the sharp black lines are replaced by blurred markings. The authors feel that these represent areas oxidized by the incoming gases which pass along the slits caused by the removal of graphite under the influence of the pressure of the originally dissolved gases.

Although large holes are numerous in the fully grown alloy, a field free from holes was selected to illustrate the final structure, as it enables the resemblance and the contrast to the original alloy to be most readily seen.

A. Wolff, superintendent of motive power, of the United Railway and Electric Company, commenting upon the growth and final failure of some fittings in one of its power houses at Baltimore, had assured the authors that the temperature was not constant, varying between that of the temperature of saturated steam at 175 pounds to superheated steam of 500 to 550 degrees total temperature.



No. 1 No. 2 No. 3 No. 4 No. 5

FIG. 2. PHOTOMICROGRAPHS OF CAST IRON SHOWING THE EFFECT OF REPEATED HEATING

The experiments which Mr. Rugan had made developed considerable evidence that cast iron subjected to varying temperatures from, say, 450 up, shows evidence of an oxidation of the silicon present, forming silica in a microcrystal form, which upon the cooling of the metal causes a disintegration of the surface exposed, ranging along the planes formed by the graphite, changing an apparently solid wall, No. 1, into one showing many cracks, No. 5. It is the constant recurrence of these conditions, produced by the varying temperatures, that in time not only produces growth but breaks down the structure of the metal.

Mr. Rugan did not believe that actual contact with steam is a necessary condition. Mr. Wolff states that the cracks observed appear to be the largest upon the outer surface. These may be enhanced by the steam pressure, but he did not believe that influence to be of as great importance as the presence of oxygen.

The paper, of which Mr. Rugan's discussion is largely an abstract, will be found in the Proceedings of the Iron and Steel Institute of London, for the year 1907.

B. R. T. Collins, of the Stone & Webster Company, said that he had run across valves located as Professor Hollis had described, so as to be subjected to excessive expansion strains. The valves were extra heavy and had ribs between the flanges. In three of these valves there were cracks 1½ inches deep in the fillets. One valve cracked an inch deep in one of the ribs. Another showed when examined with the microscope small criss-cross cracks on the outside. This valve was sent to Professor Miller for test purposes.

Professor Miller said that the valve showed upon test a tensile strength of something like 11,000 pounds. The iron was very coarse, with crystals something like one-eighth of an inch across, and it was about as poor a piece of cast iron as he had ever seen.

Mr. Collins said that the length of the value was $18\frac{7}{32}$ inches. The catalog length was 18 inches, indicating an increase in length of 7/32 of an inch.

George A. Orrok of the New York Edison Company said that when they

first considered the use of superheated steam there had been developed a type of steam piping which most engineers considered excellent. The pipe itself was of steel with Van Stone flanges.

This piping system with saturated steam gave absolutely no trouble. The upkeep of such a system under power-station conditions with 200 pounds steam pressure over a period of a number of years was almost nothing; in fact, less than $100 was spent on the pipe line in about three years.

Superheated steam introduced another factor. From certain tests which the General Electric Company made it was considered that this superheat might vary over 200 degrees and the temperature strains brought upon the piping and the valves would thus appear to be severe, and it was determined to make the entire pipe line of steel. The steel valves were of various makes, both single- and double-wedge. Their experience with the steel valves has been very good and they are giving better satisfaction than was to be expected. Troubles have developed with the steel fittings and valves due to blowholes. Most of the blowhole difficulties were traced to improper molding, improper gating and to over-oxidized metal in the case of bessemer steel and cold metal in the case of open-hearth steel. The valves and fittings which they have used are about equally divided between the two makes of steel. Their troubles with the steel lines and superheat are now practically over, and on one steam main in particular they have done nothing in a year and a half.

After their first installation of steel fittings and valves he had occasion to look up a number of power stations in which cast-iron fittings and valves had been installed for use with superheated steam. In one of these stations he saw fittings which were supposed to have been made from the best air-furnace iron in the market, which had been under the action of superheat for approximately nine months. In one station none of the castings had gone to pieces but practically all had developed leaks, and were being replaced with steel. At another, a cast-iron valve had gone to pieces, causing quite a little damage, and many other valves and fittings had been seriously affected. In this station there were a number of vertical engines on which the superheat had been used. All the high-pressure cylinders had cracked in two or three places and on his visit to the plant they were replacing the cylinders and had so arranged their pipe line that no superheated steam could get to them. A number of the fittings which had been taken from the superheat line in this station had all undergone an increase in size and the outside was covered with fine hair cracks and seemed much swollen. Analyses of the metal showed a silicon content of from 1.88 to 2.33 per cent., the phosphorus was about 0.7 of 1 per cent. with low manganese and almost no combined carbon, 2.5 to 3 graphitic carbon. The tensile strength of the material after its exposure to superheat was, in the case of the iron with the silicon content of 1.88 per cent., about 4500 pounds per square inch; in the case of the silicon content of 2.33 per cent. it averaged about 8500 pounds per square inch. It was not known what this was when it was first made. Photomicrographs were made of the etched surfaces of this metal and show the open character of the iron. In this station the superheaters were removed and the trouble ceased. When they took up the subject of superheated steam a few years ago he supposed as did everybody else that superheated steam could not exist in the presence of water. He has found it quite possible to have a layer of superheated steam above and a stream of water flowing along the bottom of the pipe. When he was in the iron business they tried to make a grade of iron that would sell well. They found it in a high-silicon iron with a large amount of graphitic carbon and no combined carbon. This iron would work well in the tools and was popular. He thought that perhaps the lack of trouble in Germany was that these people were willing to use a finer grade of white iron and spend time and money machining it. They had not found any man who could guarantee that the iron he turns out as air-furnace iron or gun iron will be regular in its composition.

W. K. Mitchell, of the W. K. Mitchell Company, Philadelphia, said that after they had been using cast-iron fittings and valves under rather severe conditions for some years trouble occurred in a railway power plant. The plant had been running for several months under a fairly constant load, but it was decided to cut down the service to one-half or less, which made the load quite variable Three months after this the trouble with fittings and valves began to develop. It was found that the valves could not be closed tight and gaskets were giving trouble. Fittings began to show signs of weakness, cracks appearing on the surface in rather dangerous numbers. The most serious of these cracks occurred at the junction of the flange and fitting and grew to such an extent that it was deemed necessary to replace several of the fittings. It was then noticed that they had lengthened considerably, some 8x6-inch double-tee fittings being 35 inches originally and when taken out measured 35⅝ to 35¾. Open-hearth cast-steel fittings and valves were substituted and have been working satisfactorily ever since.

The plant in which the fittings above referred to were used was designed for a steam pressure of 175 pounds, superheat intended to be 150 degrees Fahrenheit. That this temperature had been exceeded was evidenced by the fact that a trap which was set upon a pine board had charred holes into it where the legs came in contact with the board until the trap was simply suspended upon the pipe. They concluded that, in this plant, the damage to the fittings and valves was not caused by the high temperature, but by the constantly changing temperatures. In a cotton-mill plant installed previously where the requirement for pressure was 200 pounds and the superheat from 200 to 250 degrees Fahrenheit, fittings and valves were made of cast iron; but in that period they had heard of no trouble. In the cotton mill, the load was practically constant. No particular attention had been given to the details of the piping other than to make it amply strong for the pressure.

On account of the discussion then going on regarding the disastrous effects of superheat on cast iron, the owners of the mill became alarmed and arranged, at Mr. Mitchell's suggestion, to have measurements made periodically of the fittings on lines in which superheated steam was used. The first installation had been made in 1903, the second in 1906. In March, 1909, some of the fittings showed an increase in length that was thought to indicate danger in their continued use and steel fittings were installed during the present year. Most of the original valves are still in service, and they have no record of any failure.

Some of the extensions shown by the records are as follows:

In 1903 a 12x10x8x6-inch cross measured 24 inches in length. In 1909, it measured 24 21/64 inches. A 10x8x8-inch tee was 24 inches long, which grew to 24 5/16 inches. A 12x12x8x6-inch cross 20 inches long in 1903, was 20 9/64 inches long in 1909. In 1909 a 12x10x8x6-inch special cross was 50 inches long. In 1909 this cross had grown to 50½ inches. A 10x8x8-inch tee 24½ inches long in 1906, was 24 47/64 inches in 1909.

This seems to show that even at high steam temperatures if cast iron can be kept at a uniform temperature and not cooled off too frequently or too rapidly, it will meet the requirements of superheated steam for a long period. On the other hand, if the temperature is subject to frequent changes, such as occurred in the railway plant, it will become disintegrated and fail within a short period of time.

Referring again to the fittings which failed in the railway plant, the cracks were always on the outer surface and never went through. In an 8x6-inch double tee, the metal of which was about ⅞ of an inch thick, it was found that these cracks did not go in more than half way, which would indicate that there was no advantage in having very thick

castings under such conditions. In another street-railway power house which had been in operation for a number of years with saturated steam at 200 pounds pressure, cast-iron fittings, valves and pipe had been used successfully. During 1906 fourteen new boilers equipped with superheaters, which were intended to give a superheat of about 50 degrees Fahrenheit, were added. New piping was installed, with cast-iron fittings and valves, steel pipe with steel flanges. On account of the high pressure carried the fittings were made unusually heavy. A 16-inch tee in the connecting pipe between the main headers was found to be leaking. The leak became worse, the covering was taken off and it was found that the tee was covered with small cracks or fissures, a few of which had worked through to the inside. The tee was examined and proved to be something of a curiosity. Its original dimensions were 31 inches face to face, by 15½ inches center to face, and being carefully measured it was found that the tee had grown on one side to 31⅞ inches and on the other side to 32½ inches. The flanges which were originally 25 inches in diameter had grown to 25¾, and as they had been bolted up to the steel flanges which had not changed under the superheat conditions, they had dished themselves to a depth of about ⅛ of an inch. The original thickness of the body of this fitting, as near as could be determined from the pattern, was about 1¾ inches; but where the surface cracks were most numerous, careful measuring gave a thickness of almost 2¼ inches, and the thickness of this fitting was quite uniform throughout.

In this plant the trouble did not stop with the fittings. Several valves began to show cracks. Then the high-pressure cylinders of the engines became affected. It was decided to take out the superheaters and the plant is now running without superheat. This is a street-railway plant and subject to changes of temperature. A drawing showing the original dimensions of the 15-inch tee referred to, and its dimensions after coming out of the line, is shown in Fig. 3.

Mr. Mitchell's opinion is that where the load is constant and the temperature of the steam constant, properly designed piping with cast-iron fittings of good material will do the work satisfactorily and be safe for a long period. He does not believe that any advantage is gained by using any of the iron alloys known as semisteel, ferrosteel, or gun iron, because in the railway plant first referred to the fittings were made of iron cast in one foundry, gate valves were semisteel made in another, stop, check and emergency-stop valves were also of semisteel made in a third, and the results in all cases were practically the same. A specimen taken from an 8x6-inch double tee which had been in service about nine months gave a tensile strength of 13,750 pounds, and a chemical analysis as follows:

Carbon	0.2502
Phosphorus	0.461
Sulphur	0.083
Silicon	2.435

Two test pieces taken from the 16-inch tee referred to showed a tensile strength of 4970 pounds for the first piece and 4340 pounds for the second. A chemical analysis follows:

Silicon	2.33
Sulphur	0.07
Phosphorus	0.68
Manganese	0.39
Carbon	3.18

While open-hearth steel castings seem to be successfully used under superheated steam conditions, Mr. Mitchell did not believe that they would last indefinitely on account of their thickness. The changes taking place in these fittings due to temperature changes must be similar to those of cast iron, but the ductility of open-hearth steel will undoubtedly delay the process of disintegration. The material which they recommend and use today for high-pressure superheated steam is wrought-steel construction throughout, with welded nozzles.

John Primrose, chief engineer of the Power Specialty Company, said that during eight years he has been in close touch with upward of 1500 installations using superheated steam. Almost without exception these plants use cast-iron fittings in their pipe connections. The fact that no one of them ever reported trouble with their cast-iron fittings makes desirable an explanation of the several exceptional instances where such failures are reported. In order that there can be no doubt about the absence of trouble due to superheat, letters were written to the ten concerns known to have been passing superheated steam through cast-iron fittings for the past eight years, asking the following questions:

Question 1. Are not the tees and elbows and valves in branch and main steam lines leading from the boilers of cast iron?

Seven answered "yes;" two replied that some fittings and valves were of cast iron and some were cast steel, and one replied that the fittings were originally cast iron but that some tees had been changed to cast steel, but stating positively that the change was not made because of any ill effect of superheated steam.

Question 2. Are fittings of extra-heavy or standard rate?

Nine replied that they used extra-heavy fittings, and one standard.

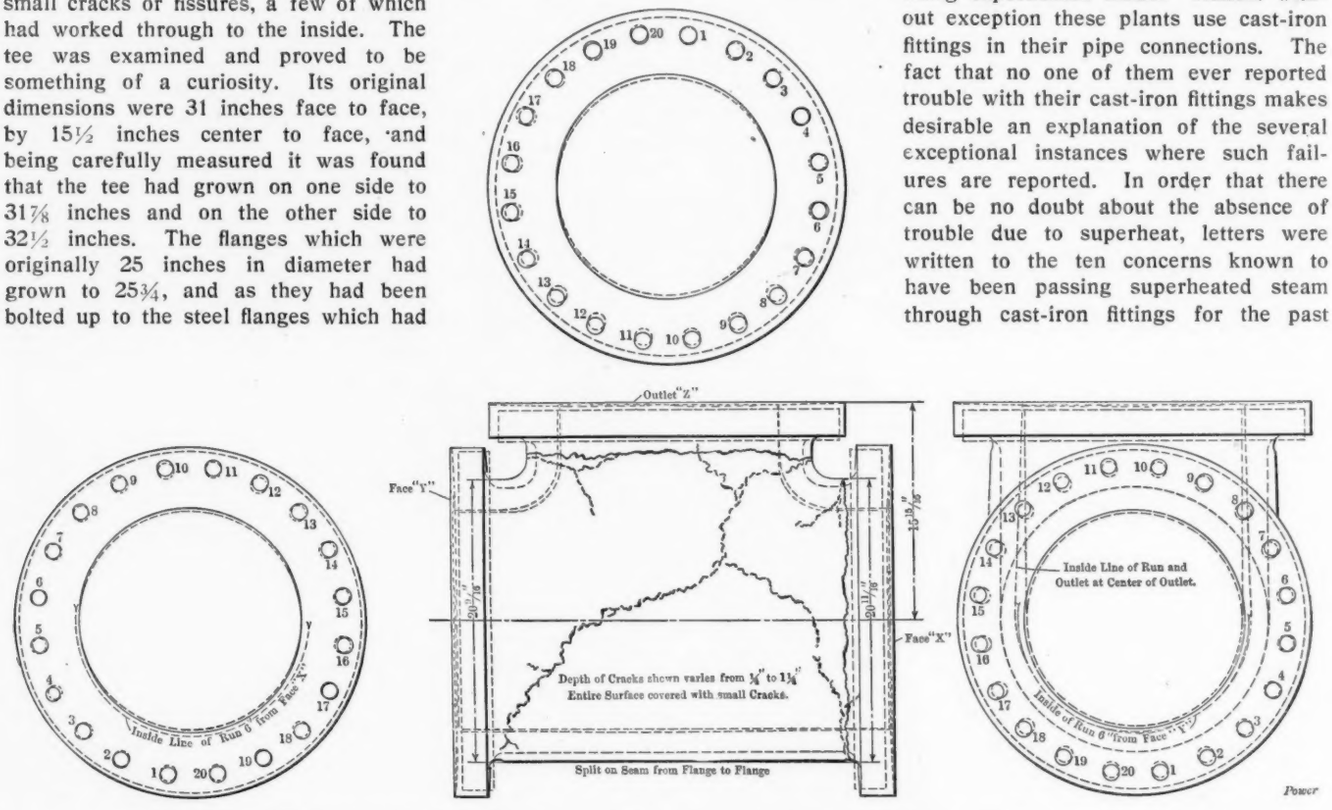

Outlet "Z"
Face "Y"
Face "X"
Depth of Cracks shown varies from ¼" to 1¼"
Entire Surface covered with small Cracks.
Split on Seam from Flange to Flange
Inside Line of Run and Outlet at Center of Outlet.
Inside Line of Run 6" from Face "Y"
Inside Line of Run 6" from Face "X"
Power

FIG. 3. FIFTEEN-INCH TEE CRACKED AND DISTORTED BY USE IN SUPERHEATED STEAM LINE

Question 3. What steam pressure do you ordinarily carry?

One used a steam pressure of 100 pounds, six used 150 pounds, one used 165 pounds, one used 185 pounds, and one used 200 pounds.

Question 4. Have you ever noticed any injurious effects of the superheated steam on your valves or fittings?

Eight answered "No;" one had no trouble with expansion in fittings, but the valves with cast-iron bodies and brass seats were giving trouble, and one reported no trouble further than the baking of a hard deposit on the inside.

Question 5. Have you ever found it necessary to replace any of these valves or fittings with cast steel?

Eight answered that no fittings or valves had ever been replaced on account of superheated steam; one answered that they had replaced no fittings except globe valves, and one answered that they were replacing some fittings with cast steel, but upon further inquiry it was found that this was not because of any ill effects of superheat, but because the steam mains were being changed to Van Stone joints and they wished to change the fittings to standard lengths and deemed it advisable to use cast steel.

Question 6. Of what material are the gaskets in the steam lines?

Seven used corrugated copper or bronze, two sheet packing and one asbestos.

The chief engineer in charge of a plant in the middle West of some 20,000 horsepower writes that nothing has developed in any of the cast-iron fittings to show that they are in any way affected by the use of superheated steam. This plant has been in operation about five years.

Such evidence proves pretty conclusively that superheated steam does not have an injurious effect on cast iron. There seems to be no very good reason why it should. Several cast-iron fittings have failed when passing superheated steam. There is something extraordinary about this, and the failures are probably due to inferior metals or to strains developed by expansion or contraction of the pipe lines, as suggested by Professor Hollis and Mr. Mann. These are much more plausible theories than that superheated steam at a temperature of 500 or 600 degrees Fahrenheit has any effect on the metal. The investigations by Mr. Outerbridge and Professors Rugan and Carpenter start with temperatures of 900 Centigrade, 1652 Fahrenheit. Such instances as the growth of grate bars, etc., are all at temperatures far exceeding anything used in superheated-steam work for power plants. Samples of cast iron taken from fittings passing superheated steam for years have been polished and photomicrographed before and after etching and compared with samples treated in the same way taken from fittings passing saturated steam. There is no evidence of a change in the carbon condition or of exposure to superheated steam. In support of this a well known foundryman gives it as his opinion that a temperature below 900 degrees Fahrenheit would not produce any effect on cast iron. The tests of the famous Crane valves, so often quoted, did not prove that superheated steam was responsible for the failure. Test pieces from the broken valve were compared with samples taken from the same heat from which the valve was made, and the valve was said to have weakened. Castings from different parts of the same heat or in fact different parts of the same casting are known to vary in strength, and it is quite likely that fittings passing saturated steam, if compared on the same basis, will be found to have suffered greatly from the effect of saturated steam. It is rather remarkable that the body of the valve is said to have been weakened more than the flanges; the reason given is that the metal of the body was nearer the superheated steam. Is it not more reasonable to suppose that the metal of the body weakened more than that of the flanges, because it was subjected to greater fatigue on account of expansion and contraction of the pipes?

Mr. Primrose's experience with cast-steel fittings used for pressure parts of superheaters exposed to hot gases had led him to conclude that that metal is anything but a satisfactory one for fittings. It is difficult to get steel castings of metal sufficiently homogeneous to hold pressure. A large percentage of castings are doctored before leaving the foundry, but new openings frequently develop on tests after machining, and even after the castings are in place, which is further evidence of strains developing in service other than those produced by internal pressure, which open up cavities or spongy places not discovered by the shop test. Steel castings vary greatly in toughness as is shown by the great variation of elongation on test. Others are so hard that machining is very difficult. The greater tensile strength of cast steel is not a necessity, and cast iron made by careful specification and amply strong to take care of expansion stresses can be relied upon to hold pressure. Attention should be paid to the design of the pipe lines to avoid overstraining the fittings. Where long bends are the means of taking up the movements, pipes of the lightest possible weight consistent with safety should be used, thereby lessening the strain required to swing the pipe. With properly connected flanges full-weight pipe is amply strong for all ordinary working pressures, and if drawn tubing is used, even lighter weight may be employed.

H. S. Brown, who presented Mr. Primrose's discussion, said that he did not think that the temperature in the ordinary New England plant was sufficient to cause serious trouble, even where superheating is used, but it is the fluctuation in the temperature. If one could keep the temperature constant, the trouble in cast iron would be eliminated.

E. H. Foster, president of the Power Specialty Company, said that having devoted the greater part of his time for the past ten years to the study of superheated steam and the manufacture of superheaters, he had eagerly followed up every report of the failure of a steam-pipe fitting where superheated steam was used, and that it could be fairly said that no instance had yet occurred where the weakness has not been readily explained by the poor quality of the iron, or by lack of provision for expansion and contraction. It is just as important to have regard to the mixture of the iron to be used in cast-iron fittings as it is to secure the proper mixture for concrete work. Of course, more expansion is to be expected with superheated steam because of the higher temperature, but it can be very easily taken care of without placing any additional strains on the parts.

L. B. Nutting, also of the Power Specialty Company, asked if superheated steam *per se* causes trouble, why is it that superheaters which they had installed nine years ago and which have been in constant use (superheaters of earlier design than they are now using being made entirely of cast iron, having a smooth bore and corrugated exterior) have not caused any trouble and have not changed their dimensions. They had installed and had in operation a great many superheaters delivering steam at a temperature of 1000 degrees Fahrenheit. They have been surprised to find that users have employed without any trouble whatever, or any distortion, or without any evidence of weakness developing, a standard make of cast-iron valves, globe and gate, under this temperature. It is true that the temperatures were maintained at 1000 degrees without a variation of 25 degrees all the time.

Mr. Mitchell suggests that provision should be made to obviate troubles from varying temperatures on cast iron, but why not make provision so as to have constant temperature? Mr. Nutting thought that the art of superheater construction had advanced to such a point now that a uniform temperature can be safely counted upon, and the plant that Mr. Primrose had referred to, a 20,000-horsepower boiler plant, had a record of variation not exceeding 10 degrees either way from the desired temperature at any time during the year, although the load had a fluctuation from 5000 to 35,000 kilowatts.

W. B. Leach, general manager and treasurer of the Hunt-Stiller Manufactur-

ing Corporation, which makes a specialty of air-furnace gun-iron castings, said that his company had been for the past few years making superheater headers for locomotive work. These are exposed to a great heat from the gases immediately after they pass through the tubes and are, in connection with the superheated steam within, subjected to the hardest possible test. These castings are made very thin, but so far as had come to his knowledge, no trouble has ever been experienced with their metal in these parts. Repeated orders from them of castings for this work by the same concern would seem to indicate that no trouble had been experienced.

Andrew Lumsden, president of the Lumsden & Van Stone Company, said that in one case they had eight boilers of the Babcock & Wilcox type, part of them equipped with a well known superheater and part of them equipped with a superheater made and installed by the boiler company. These boilers are all connected to one 12-inch main through long-radius bends. On the superheater installed by the boiler company they had usually 150 degrees of superheat, and from the other superheater they got about 90 degrees.

When this plant had been in service about two years they found some of the fittings in the main were leaking just back of the fillet, and upon examination found small cracks extending around one side of the piece. They at once had some long bolts made to go through the whole length of the piece, and through the end flanges, using them also to make the joint. When these old fittings had been replaced by steel ones, it was found that they were from ⅜ to ½ inch longer than when first installed. This is a turbine station, and since that time they have had quite a little trouble with the admission valves on some of the turbines, those directly opposite the boiler carrying 150 degrees superheat, giving them by far the greatest bother. At another plant there are boilers of the Babcock & Wilcox type and Curtis steam turbines. This plant was installed seven years ago. At that time a separately fired superheater was installed, on which exhaustive tests were made, and the temperature of the steam leaving the superheater ran as high as 750 degrees. This superheater was run nearly all the time for about six months, and at the end of that time all of the copper gaskets were destroyed and the joints had to be remade, and the superheater was shut down and has remained so ever since. Mr. Lumsden had visited this plant a few days before and had found everything in very good shape; no large joints have been made since that time. There are about 90 joints from eight to twelve inches and none of them have leaked since, but there are a number of 12-inch valves in this line, all of 250-pound pressure type, three of them leaking badly through the body on the underside and about the point where the ring seats are screwed in. These valves are laid on the side and are on the boiler side of the superheater and have never had superheat in them. In the writer's judgment, these troubles cannot be due to expansion as particular care was taken to allow free movement to all piping in the plant.

Another plant where they have Babcock & Wilcox boilers, Curtis steam turbines, etc., had come under his observation. They have carried 150 pounds steam pressure at 150 degrees superheat for about six years with cast-iron fittings, and have had no trouble with the fittings. The valves have given them some trouble with loose seat rings and being badly cut. They were about to remove one of the fittings in the main, replacing it with a steel fitting in order to have the cast-iron fitting tested.

John C. Parker, president of the Parker Boiler Company, said that six or seven years ago he was called upon to furnish superheaters with some of his boilers, and had worked out a design according to his own ideas and had since equipped 40,000 or 50,000 horsepower boilers with the superheater so produced. A couple of plants in which they were used exceeded 10,000 horsepower each. In six years' experience they had had no trouble with either the cast-iron or steel fittings, valves or cylinders. He ascribed the results to the steadiness of the superheater and to the fact that condensed steam in the superheater is never allowed to get into the steam lines.

He did not believe that there is any connection between the troubles which some designs of superheaters made and the expansion of the steam main. In one of their first installations the men started to flood the superheaters without his knowledge whenever the boilers were banked, and the result had taught him the effect of suddenly injecting water at 360 degrees Fahrenheit into piping and headings which had been raised to 500 degrees. The leaks started at the joints, and stopped as soon as the practice was stopped.

He believed that the troubles which have occurred have been due solely to fluctuations in temperature and temperature shocks, caused by frequent injections of condensed steam from incorrectly designed superheaters. He had recently seen a plant where a superheater of German design had been in use for about four years. It was an independently fired superheater and the engineer had had so much trouble with piston rings in an engine with poppet valves, designed especially for superheated steam, that he had cut the superheat from 600 degrees Fahrenheit to 500 degrees and then to 400 degrees. He had his ideas centered on the point at which the trouble occurred, the cylinder and rings, and would not believe that it was due to fluctuation. He was finally pinned down to the statement that "the temperature could be controlled perfectly; it was easy, but you had to watch it like a cat." Mr. Parker imagined that the cat went to sleep at times and that is when the piston rings "went to powder," as the engineer expressed it.

There is a superheater on the market which uses cast iron to protect wrought-iron tubes. He had seen some of these removed from boilers on account of overheating, and while the cast iron had been red hot, it was in better shape as regards cracking than some steam-pipe fittings which were subjected to water jets and steam fluctuations under 600 degrees.

The reading of the frank statement of Mr. Parker (who was not present) that he did not think Professor Miller's (who was present) experiments were "worth anything at all," raised a laugh at the expense of the professor. Mr. Parker thought it would require at least a half dozen tests of the same sample of cast iron at progressively increasing temperatures and periods to obtain any results from which conclusions could be drawn. Ten of the tests show increased strength of cast iron, while in all, the steel had lost strength. One steel test, 100,000 pounds, is unreasonable. They had sixteen 800-horsepower boilers with superheaters directly over the fire, running at 175 pounds pressure and up to 170 degrees superheat, with no such trouble as Mr. Mann mentions. "Leaving open-hearth steel castings for gun iron" is catching at very weak straws, and it looked to him as if there was something radically wrong with Mr. Mann's superheater.

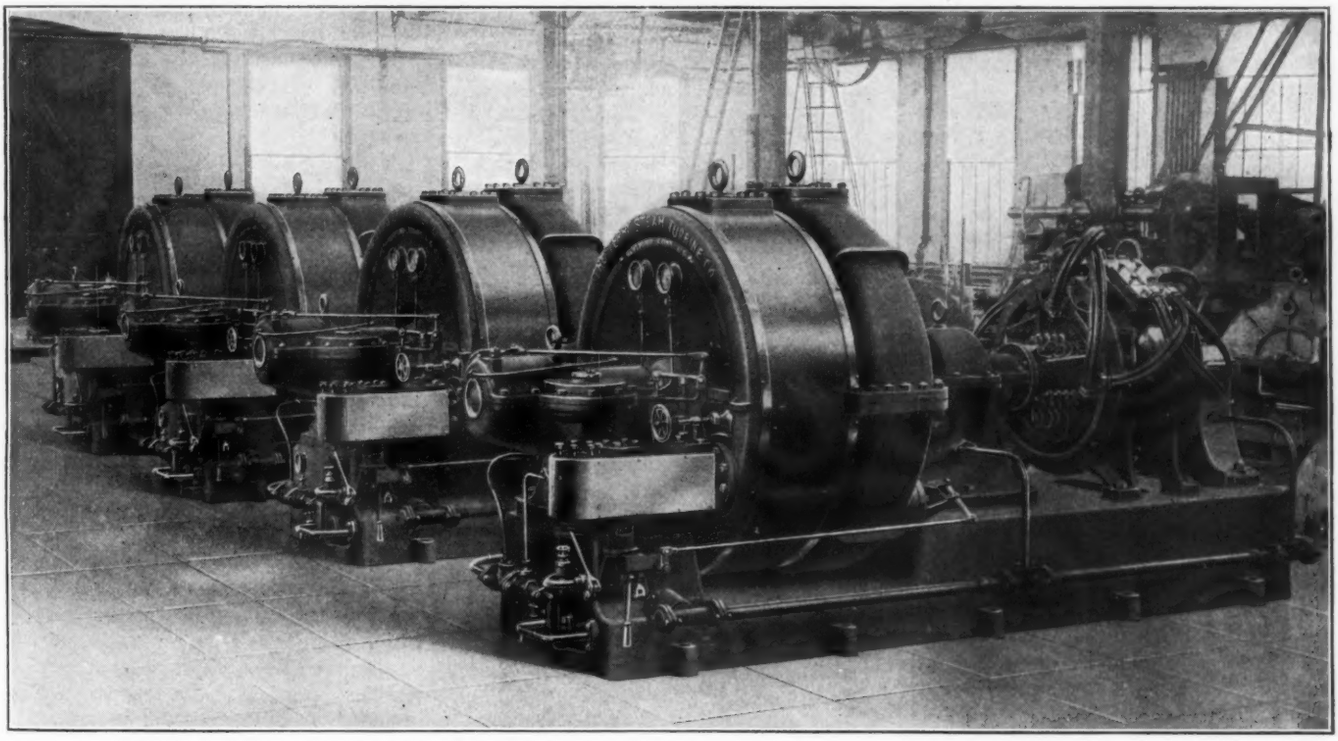
Professor Jacobus, advisory engineer of the Babcock & Wilcox Company, contributed a written discussion. In a large power plant which he had in mind, where the fittings were all of cast iron, and where the superheat averages 150 degrees, repeated examinations have failed to reveal deteriorations. In other cases, however, where there has been less superheat, and even where a single boiler with superheated steam has been connected into a common main, to which a number of other boilers furnish saturated steam, there has been every indication that a small amount of superheat had had an injurious effect. It therefore seems that a difference in the quality of the cast iron may affect the results, and it may be that by making a careful study of the matter someone will be able to determine wherein any particular grade of cast iron differs from another, and that there is a possibility by knowing the analysis of the cast iron that its action under superheated steam may be predicted. In the meantime the Babcock & Wilcox Company is furnishing cast-steel fittings for all superheated-steam work.

as it does not know of a single case of the failure of such fittings that can be attributed to the action of superheat.

In the case of old fittings which have broken in superheated-steam lines they had found that there was a stress at the point of rupture entirely apart from the stress produced by the steam pressure. In the ordinary form of flanges the tension of the bolt produces a cross strain, and the fittings yield where they would naturally fail through this strain. They had given considerable thought to the discussion of a form of flange in which such a cross strain would be eliminated and have not pushed the matter forward as they have decided to eliminate all doubt as to the safety of the fittings by employing steel castings throughout. Professor Miller's tests show that although there is a general falling off in strength when all of the tests are considered, the cast-iron specimens in one case did not lose in strength by being subjected to a high degree of temperature. In connection with such tests it would be interesting to investigate the action of superheat when the metals are under stress. Mr. Mann's conclusion that gun iron was better than cast steel is indeed interesting, but they would not think of changing their present practice of using cast steel until gun iron is thoroughly tried out in the practical field, and experience has demonstrated that it is all right for the work.

Turbine Generating Sets in the Navy

The United States steamship "Connecticut," flagship of the battleship fleet, has recently had installed in her forward dynamo room four 100-kilowatt turbine generators to replace as many high-speed engine-driven sets. These are shown in the illustration, assembled at the Hartford works of the turbine builders, the Terry Steam Turbine Company.



THE "CONNECTICUT'S" TURBO-GENERATORS ASSEMBLED IN THE SHOPS

The turbines are of the two-stage type, designed to operate with 200 pounds initial steam pressure and 25 inches vacuum, at a speed of 1700 revolutions per minute. Steam enters through the throttle valve into the strainer, then passes through the emergency valve which is kept open against a spring by a trigger, and finally through the governor valve controlled by the main governor.

The emergency valve is tripped either by the emergency overspeed governor on the vertical worm shaft, or by the relief valve on the low-pressure stage, which is set to blow off at about 15 pounds pressure. A flyball type of governor direct connected to the turbine shaft operates a balanced miter throttle valve.

Steam passing through the controlling valve enters the first set of high-pressure steam jets, and from thence the wheel and multiple velocity stages characteristic of this turbine. After doing its work in the high-pressure stage, the steam is again expanded through similarly arranged nozzles and reversing chambers in the low-pressure stage, after which it passes through the exhaust to the condenser. The glands are of the labyrinth type, steam packed.

Full load can be obtained when exhausting noncondensing, by opening an additional valve in the high-pressure stage.

Expansion is taken care of in every way without undue distortion, or without affecting the alinement of the bearings. The turbine casings are bolted to and supported by the main bearing pedestals, no feet being fitted on the casings themselves. In this way freedom for expansion is obtained, the forward pedestal being provided with a sliding foot.

Positive oil circulation is maintained to all bearings by a centrifugal pump at the bottom of the vertical worm shaft. The oil is drawn from the reservoir in the base of the turbine under the forward pedestal. This reservoir is provided with coil pipe for water cooling. The oil is drained back from the bear-

ings through filters into the reservoir.

A flexible coupling connects the turbines to the generators. The generators are 100-kilowatt, 125-volt, direct-current, compound-wound machines, fitted with inter-commutating pole pieces. The double commutators are of special design, adapted to high velocities, and are mounted on a spider which in turn is substantially keyed to the armature shaft. The brush area is proportioned for low current density. These sets are built to conform to the Bureau of Equipment specifications.

The increasing extent to which electricity is being used for lighting and power on board our battleships is shown by a comparison of the "Connecticut's" dynamo equipment with that of the "Florida" or "Arkansas" now building. The "Connecticut" has eight 100-kilowatt units, while each of the new ships is to be fitted with four 300-kilowatt sets.

Leasing Public Oil Lands

In connection with the recent action of the Administration in withdrawing from entry over 3,000,000 acres of public petroleum lands in California, Wyoming, Utah and Oregon, the following statement is given out by C. W. Hayes, chief geologist of the United States Geological Survey:

To remedy the present unsatisfactory conditions by which public oil lands have to be entered under a law framed primarily to provide for placer-gold mining entries, it is generally admitted by those interested in the development of oil lands that a radical revision of the American mining law is necessary. Anticipating that Congress will recognize and meet this evident need, the Secretary of the Interior has withdrawn from all forms of entry all vacant public lands designated by the Geological Survey as probably containing oil and gas. This executive action, is, however, only temporary, and is intended to preserve the *status quo* until Congress acts.

When the present placer-mining law was enacted probably no one in Congress or out had any idea that it would ever be made to cover mineral deposits so far removed in every essential characteristic from gold-bearing gravels as are oil and gas. Yet when oil was found on the public lands no other law was on the statute books except the placer law under which title to it could be acquired, and this anomalous and wholly unsatisfactory condition still holds—to the great detriment both of the Government and of the oil industry.

The fundamental basis of a location under the placer law is discovery, and the courts have held uniformly that there can be no legal location until there has been a discovery. But in the nature of the case there can be no discovery of oil until a well has been drilled at great expense, since ordinarily there are no surface indications of the oil and the well must be drilled upon purely geological inference. It follows, therefore, that the driller will be wholly unprotected against rival claimants to the land until he has completed his first well or he will be forced to make a false claim to discovery on which to base his location.

Fraudulently Entered as Gypsum and Agricultural Land

One very common method of evading the law is to locate oil under the guise of a gypsum claim. In many of the California oilfields the surface soil contains a small amount of gypsum, although rarely in sufficient quantity or purity to be profitably mined, even if favorably situated for transportation and market. It affords a pretext, however, for a location under the placer law, and large numbers of claims have been patented where it is a matter of common knowledge that the real object is to acquire title to the oil. In this way land worth thousands of dollars an acre has been acquired from the Government for $2.50 per acre, and this without oil development. Moreover, it is not generally the man of small means, but rather the wealthy corporation that resorts to this subterfuge to secure title.

Although many of the oilfields in the public-land States, and particularly those in California, are in regions wholly devoid of agricultural possibilities, no sooner is a successful well drilled than the entire district is covered by homestead and scrip entries, the purpose of which is to secure title to the oil under cover of the agricultural-land laws. It is to meet these conditions that a thorough revision of the law is needed.

Oil-leasing System in General Practice

Any law which will adequately meet the requirements of the case must recognize the fundamental difference between oil and gas and other minerals, namely, mobility. These elusive products can be drawn from a distance underground across boundary lines, and exclusive title to the product is acquired only after it reaches the surface. It follows, therefore, that oil can be disposed of by the Government or other owner of the land in which it occurs only as a commodity and not in terms of acres like coal or other minerals occupying fixed locations. This difference is so well recognized that it has determined the leasing system which is practically universal in all the oilfields where the land is in private ownership. The Government cannot do better than to adopt the plan which has been worked out through long experience, and, where the holdings are sufficiently large, found thoroughly satisfactory, both to the oil operator and to the private land owner. Why should not the Government as a land owner deal directly with the producer rather than through the intervention of a middleman to whom title to the land has passed?

Any ideal or practical law must further recognize the fact that actual discovery involves heavy expenditure and considerable time, and that the prospector must be adequately protected in his investment before as well as after the discovery is made. The area to which he is given a preferred right must therefore be sufficiently large to justify his initial heavy investment and in such compact shape as to protect his discovery from encroachment by drilling on subsequent entries.

A well considered leasing law will give certain incidental advantages of great importance both to the Government and to the oil operator. It will constitute the most effective means for the conservation of the oil and gas resources of the country by enabling the Government to regulate developments so as to prevent much of the criminal waste now prevalent.

Present Law a Hardship

Under the present system the owner of a 20-acre placer claim is compelled to drill and pump the oil from his land with all possible speed, regardless of transportation facilities or market, for otherwise his competitors on adjoining claims will take a large share of it away from him. In the resulting feverish exploitation half a dozen or more wells may be drilled when one would have secured the same amount of oil—a serious economic waste to the nation and a heavy tax on the ultimate consumer. Also, unrestricted drilling by careless or ignorant operators may ruin a valuable field by admitting water to the oil sand from a higher or lower water-bearing stratum. Many examples of criminal waste resulting from the unrestricted exploitation of oilfields might be cited.

Oil for American Naval Vessels

The Government is not only the largest owner of oil lands, but it is likely to be the largest consumer. The six largest battleships in commission or under construction in the American navy are equipped for the use of either oil or coal, and the fourteen largest destroyers use oil exclusively. The question of fuel supply for these vessels is certain to become an exceedingly important one in the near future, and the law should provide a means of perpetuating a supply for this certain future need.

INQUIRIES OF GENERAL INTEREST

Questions are not answered unless they are accompanied by the name and address of the inquirer

How to Stop Leaks

How can a leak in a steam pipe be stopped by Smooth-On cement so as to hold steam under pressure?

J. I. C.

Smooth-On cement may be used for stopping leaks on the outside of pipes as follows: Whether the pipe is cast iron or lead, if the pipe is hot when the application is being made, use Smooth-On elastic cement. If the pipe is cold use Smooth-On iron cement No. 1, making the repair as follows: First thoroughly clean the opening and remove all foreign matter. Second fill the opening with Smooth-On iron cement No. 1 or Smooth-On elastic cement. When the opening is filled, plaster above and around the opening to the depth of about 1/16 inch. Allow this to harden. It will require about half an hour; then wind with two wrappings of Smooth-On tape, then cover the Smooth-On tape with another application of Smooth-On iron cement No. 1. One hour after the last application of Smooth-On, if the repair has been properly made the repaired portion of the pipe will withstand 25 pounds water pressure. At the end of 24 hours it will withstand 100 pounds. Repairs like the above have been made that have lasted five years. Where the pressure is only 5 or 10 pounds, there is no need of wrapping the pipe with tape.

Dynamos in Parallel

When running a number of compound-wound dynamos in parallel or multiple driven by separate engines under full load, and one of them has to be cut out, what is the proper way to act; some writers advise to slow down the engine and pull the main switch; how will the equalizer bus act in this case? Would it not feed over to the slower running engine, making a motor out of its dynamo? Others say bring down the load by means of the rheostat to a few amperes and pull the switch, and again it is advised to simply pull the main switch and shut down the engine. Kindly give the most practical way to act in this case. Also how dynamos of different speed and size can be made to keep up the same potential. Are the expressions running in "parallel," and in "multiple," of the same meaning?

W. S.

The safer way to shut down one of a pair of compound-wound dynamos running in parallel is to lower the voltage on the machine which is to be cut out by cutting resistance into the field circuit with the rheostat until the ammeter on that machine shows no load. The main switch can then be pulled and the engine stopped. If stopping is attempted by slowing down the engine to take the load off the dynamo there is some danger of a motor action as you suggest, and in any case, it is impossible to cut down the speed gradually enough to entirely prevent the motor effect. With a good field rheostat, the voltage can be lowered so gradually as not to bring the motor action into play. Certainly the advice to pull the main switch and then shut down the engine without first lowering the voltage to take the load off the dynamos is not good, for if the machine is carrying a heavy load, the pulling of the main switch will cause a violent spark and make bad work with the switch blades.

The potential or electromotive force of a dynamo depends not only on its speed and size, but on the number of turns of wire put on the armature and the strength of the field. When a designer plans a machine, he calculates the right field strength, and the turns of wire in the armature to give him the desired potential at the speed at which the machine is to run.

Dynamos running in parallel or multiple are the same thing, and it means that the dynamos are feeding the same set of busbars.

Valve Travel; Increasing Horsepower

If a plain slide valve has ½-inch lap and 1-inch port opening, what will be the length of travel? How can the power of an engine be increased?

F. L. J.

The lap of a slide valve is measured at one end of the valve only, and may be found in two ways, first, by subtracting the distance between the outer edges of the steam ports from the length of the valve face and dividing the remainder by 2, or second, by placing the valve in its mid-travel position and marking the valve seat at the end of the valve. The distance between this line and the edge of the port represents the lap. Assume the valve to be in its mid-travel position and lapping the ports ½ inch. In order to open the head-end port wide, the valve must move a distance equal to the lap plus the port opening or 1½ inches. The valve is now at the end of its travel in the direction of the crank. When it has traveled 1½ inches in the opposite direction, or toward the head end of the cylinder, it will again occupy its mid-travel position, and in order to open the port wide at the crank end, it must move another 1½ inches toward the head end, making 3 inches in all. The valve will now occupy its extreme position at the head end of its travel. The travel of the valve is seen to be twice the distance necessary to open the port wide when starting from its mid-travel position; in other words, the travel is equal to twice the port opening plus twice the lap.

The several ways in which the power of an engine may be increased can best be understood by considering the ordinary rule for finding the horsepower of an engine. This is

$$\textit{Horsepower} = \textit{Area piston} \times \textit{mean effective pressure} \times \textit{stroke} \times \textit{number of strokes} \div 33{,}000.$$

It will be noticed that the divisor, 33,000, is a constant, while the values in the dividend vary according to the conditions in each case. If the area of the piston and the length and number of strokes remain the same it is plainly seen that the power of the engine, or the horsepower as calculated, will vary with the mean effective pressure employed. Similarly, if the area of the piston, the mean effective pressure and the length of stroke remain unchanged the horsepower will change in the same proportion that the number of strokes, or the speed, is changed. Again, if the length of stroke and speed remain unchanged, the horsepower will vary when the area of piston and mean effective pressure are changed; the increase or decrease in the latter case will be proportional to the product of the area of piston and mean effective pressure. Thus the horsepower of an engine can be increased by increasing any one of the values represented in the dividend, and by increasing two or more of them. When one quantity is doubled the horsepower will be double, provided the remaining values are unchanged; when two quantities are doubled the horsepower will be increased four times, and so on.

A quick method of stopping leaks in brickwork around boilers or in chimneys is to mix some asbestos (old pipe coverings will do) and water to a paste, and apply. The heat will soon dry it out.

POWER AND THE ENGINEER
DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROBERT McKEAN, Sec'y.
505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1909 *we printed and circulated* 1,875,000 *copies of* POWER.

Our circulation for December, 1909, *was (weekly and monthly)* 130,000.

January 4	40,000
January 11	38,000
January 18	38,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Boiler Room Ventilation

Winter time is always a busy season for the engineer. The days are dark, the load is heavy, live steam is being used, lots of coal is burned and the plant is taxed to its utmost. Many an engineer has lost sleep trying to keep things going under such conditions. In this connection there occurred an interesting combination of circumstances in the case of a new office building during a recent cold snap, which emphasizes how something apparently unrelated to the matter in hand will sometimes increase the tribulations of the engineer.

The building is one of those where the windows are kept shut tight the year round and filtered air is supplied in connection with a mechanical heating and ventilating plant, supplemented with direct radiation when needed.

When the chief engineer arrived in the morning things were in an uproar. Tenants all over the building were complaining of the cold, and it seemed impossible for the engineering force to get things into normal condition. Investigation showed that the heating system was in good shape and that every radiator in the building was hot, yet great quantities of cold air were coming in at the windows and at every conceivable place. The management was on the point of hiring a carpenter to put weather strips on the windows, thinking that this would be necessary before the heating system would have a chance to warm up the building.

Going down into the boiler room the engineer found everything shut up as tight as a bottle. The room was warm and comfortable, and really a cozy place, with the thermometer at six below outside. He immediately opened the ash chute and ventilating hatches, giving the outside air free access to the furnaces, and in twenty minutes all complaints had ceased. The trouble was that with the tight boiler room, the suction of the draft had lowered the pressure in the entire building to less than atmospheric, and as air had to be supplied to the fires, it was drawn in at the windows, through the rooms, along the halls, down the elevator shafts to the furnaces, and up the stack. Giving the fires plenty of air from the outside ended the difficulty.

Doubtless this is a familiar case to engineers in office buildings where similar equipment is installed, but there are thousands of plants where boiler-room conditions like this could exist, without the peculiar circumstances that would make the fact apparent, although the detrimental effect on boiler operation caused by the lack of proper air supply would be fully as great.

Engineers frequently complain that for some reason or other, their troubles always commence as soon as cold weather sets in, and in many cases, this one condition may be handicapping the plant without its being realized. A vacuum is all right in its place, but do not try to keep a vacuum on the boiler room.

Impertinent Questions

Which room are you proud of and which do you show to visitors, your engine room or your boiler room?

Which room is the lightest, cleanest and best ventilated?

How often is the floor of the boiler room swept, the windows washed and the walls painted white?

Who gets the larger pay, the man who runs the engines or the man who cares for the boilers?

Are your boilers looked after as carefully as your engines and made to realize their best efficiency in the same degree?

Have you ever compared your bill for engine oil and waste, with what you expend for keeping your boilers clean?

How long would your engine run without oil and how long do your boilers run without cleaning?

Would you hesitate to set the valves of your engine, to adjust the governor, to put on a condenser and pump, if you knew you could improve the efficiency from 10 to 25 per cent.?

Have you ever tried to improve the efficiency of your boiler plant in a similar manner?

Do you know what the efficiency of your boilers is at the present time?

Would you feed to your engine steam containing 20 per cent. of water? If so, how long?

How much ash does the coal that you are using carry? What per cent. of refuse do you actually dump each day?

How much does each ton of coal that is delivered by your dealer weigh when you get it?

How much water is there in it and how many lumps of slate?

What is the nature of the subsoil of your dealer's coal yard, clay or gravel?

Do you buy your coal on a B.t.u. basis or

do you pay according to the percentage of ash, the more ash the less money?

How is the coal fed to the fire and how often?

What draft does your chimney carry? How often and how badly does it smoke?

What per cents. of CO, CO_2 and N are in the chimney gases?

How many pounds of water do the boilers evaporate for each pound of coal burned?

Is this a fair rate of evaporation, and if not, why?

What is the nominal horsepower of your plant and how many horsepower does it actually develop?

Are you using too many boilers or not enough?

Are the fires always bright and are the tubes always clean?

Do you know that a smoky fire makes dirty tubes?

What are the constituents of the water you see in the boilers?

Do you use any boiler compound, and, if so, how do you know that you are giving the right medicine?

How is the feed water regulated and how much does the water level in the boilers vary in 24 hours?

How many times a week does the water line get below the fire line?

Does the brickwork in the setting leak, and if so, which way?

What is the average temperature of the boiler room in summer and in winter?

Who inspects your boiler and how often is it done?

What does the inspection prove?

Finally, do you realize that the place where you can save a few dollars is likely to be in your boiler room rather than in your engine room?

The engine has apparently reached its maximum as a power saver, at least in plants of moderate size. It is usually in good condition and the engineer is more or less proud of it. The engine is prompt to complain of any neglect and "he who runs may read;" the boiler labors on uncomplainingly, but in many instances is not doing its full duty for lack of intelligent care and supervision.

The engineer fusses with his indicator and tries to improve the shape of the diagram by adjusting valves or eccentric; he uses the best packing for the glands and the best oil for the bearings and for the cylinder; he listens for each click and pound and is not satisfied until he has located and remedied them. This is as it should be and makes for economical running.

We are only inquiring if he is equally interested in the boiler and its troubles. It is safe to say that in most instances, it is much more practicable to save 10 or 15 per cent. of the monthly coal bill by investigating the fuel and its burning than by making changes at the engine end of the plant. And after all, it is the coal which costs and the labor of handling coal and ash which needs reducing.

The Relation of the Building Management to the Engine Room

The relation of the building management to the engine room is, rightly, a matter of business rather than of tradition. In these days of very large office buildings, hotels and apartment houses the expenditures for engine-room equipment and supplies form a considerable part of the "running" expenses of the building, especially when the power plant includes equipment for electric lighting and elevator and other service, and machines for refrigeration and vacuum cleaning. The efficient oversight of the expenditures is more important than in the days of smaller buildings standing on land of lower value, and the status of the building engineer is more strictly defined by the degree of responsibility in them that is given him. Whether the engineer keeps his old status in the enlarged scheme of things will be shown by the confidence which the building management reposes in his judgment, breadth and honesty, by encouraging him to make the requisitions for new equipment, repairs, supplies and by honoring them as made.

Excessive operating costs in a building may be due to mistakes of officials of the building company, who are not expert in engineering matters; to mistakes in choosing and arranging the mechanical and electrical machinery so that it will operate economically as a whole; to mistakes in the operation of the plant, as by the purchase of too expensive fuel, by careless firing, bad draft, inefficient handling of repairs, extravagant contracts for electricity supply, inefficient steam heating, and so on. These kinds of poor management prevent the building from earning money just as surely as mistakes in the renting or real-estate end of the proposition.

There is a tendency at present for the building management to supervise the construction and operation of the engine-room plant, going outside for advice when confidence in their own judgment fails them. We deprecate this tendency, because we have faith in the building engineer as a man who can grow with the growth of his environment. We believe that the tendency is faulty in that it subordinates the engineer unjustly. The consulting engineer has his proper sphere, and we have always urged recognition of his usefulness to power plants, but it should not be necessary to call in an expert in order to decide upon the purchase of a pump or even an additional engine. We believe that along with the respect that is now entertained for "the chief" as the man in charge of the power plant there should go the delegation of responsibility in greater measure and appropriate remuneration. The fact that the building manager is usually a real-estate man, having no knowledge of machinery, constitutes the engineer's opportunity to prove his worth as a responsible man on the business as well as the technical side, under the changing conditions. To do this he must measure up higher than the mere engine-room drudge, with only sense enough to operate the throttle when the whistle blows, so to speak, narrowed and lowered in mental and moral fiber by loafing part of the time and working overtime on emergency repairs the other part of the time.

Modern conditions demand high efficiency in men and machinery—but the men must be efficient as men, just as the machines must be efficient as machines. The best way to command the returns of valuable services is to demonstrate them. Consideration and responsibility and good pay attend the showing of broad-gage qualities in this field, just as they do elsewhere. The building engineer who can keep pace with the enormously increased value of the land on which modern buildings stand is himself more "upstanding," and has developed more and better individual equipment for the same size shoes. He keeps abreast of his times in his chosen field; buys books, subscribes to periodicals, and absorbs their contents to his own advantage. He gives out of his best self, and thinks of efficiency, team work. He develops real contact with others; goes to conventions of his engineering societies as opportunity allows, not as a junket but for what he can contribute of value to his fellow members, and receive from them in return. The broader he grows the larger his acquaintance becomes, and the greater the percentage of strong men in it. Obviously, the salary question settles itself—it is bound to fall into line when the earning capacity has been demonstrated. Building managers are business men, looking for productiveness in the plant in which their money is invested, and the building engineer has the finest chance in the world to build himself into the core of things.

The editor of the *Mechanical Engineer*, published at Manchester, Eng., says that cast iron has been discarded in England by all competent inspecting authorities for high pressures for at least a quarter of a century, even for saturated steam, while for pipes and fittings carrying superheated steam, it has never been sanctioned. In the recent discussion of the subject of the effect of superheated steam upon cast iron at Boston two of the speakers alluded to the lack of trouble in England and upon the Continent. Perhaps "there is a reason."

NEW·POWER·HOUSE ·EQUIPMENT·

What the Inventor and the Manufacturer is doing to save time and money in the Engine Room and Power House

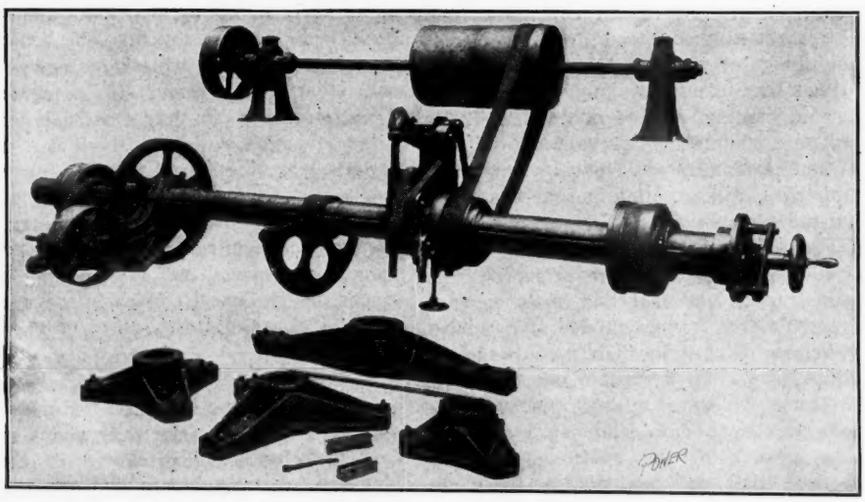
Portable Boring Bar for Steam Turbines

The illustration shows a portable boring bar fitted with a special attachment for finishing the ends of the blades of steam turbines.

The attachment may be equipped with either an emery wheel or milling cutter, whichever best suits the conditions. It travels along the bar, being fed automatically or by hand, with the feed case having two changes of feed, as shown on the end of the bar. The handwheel projecting below the attachment permits it being set for different diameters.

The bar and attachment can be driven by one motor by making the countershaft as long as the bar. The bar revolves in bearings which are supported in the ends of the casing, the same as the bearings of the turbine shaft. This insures each half being in accurate alinement. The center bearing is used to prevent any sagging and to give added rigidity to the bar. Cutterheads are included in the equipment for boring the casing and cutting grooves for the blades, when desired.

The outfit is designed and built for shop work, and also for repair work in the engine room when it is necessary to renew the blades. It is, therefore, par- Company, 1021 Hamilton street, Philaing or repairing steam turbines. It is manufactured by H. B. Underwood & Company, 1021 Hamilton street, Philadelphia, Penn.

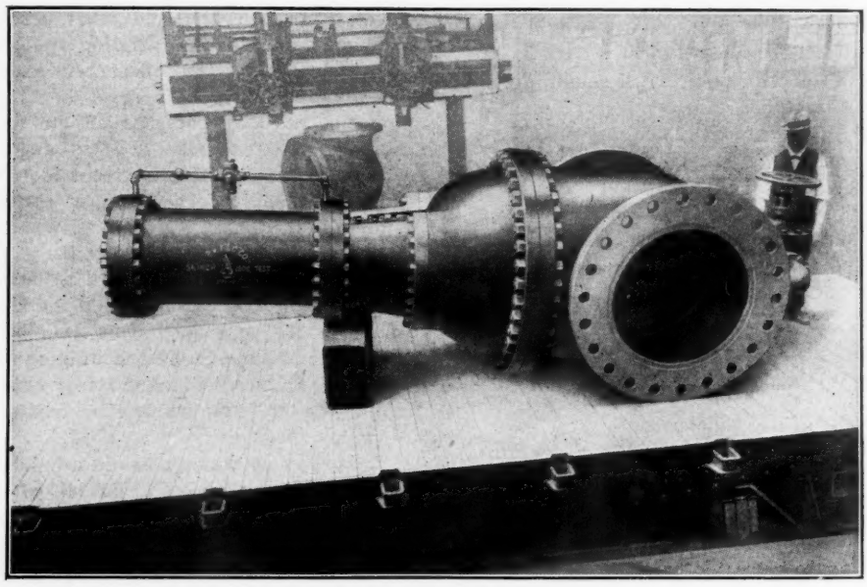


PORTABLE STEAM TURBINE BORING BAR

Large Steel Gate Valve

The illustration shows a large steel gate valve manufactured by the Pittsburg Valve, Foundry and Construction Company, for hydroelectric power-plant construction. In August, 1907, a 30- and a 36-inch valve of this type were built for the Union Construction Company, San Francisco, Cal., on an order from the company's engineers, Sanderson & Porter, New York, to be used on the Stanislaus electric-power development and in September, 1909, a second 36-inch valve of the same type was built for the same company.

These valves work under a hydrostatic head of 1500 feet and were tested to 1500 pounds per square inch in the manufacturers' shop. Steel castings were used throughout, and all surfaces were either cylindrical or segments of spheres. The valves were heavily bronze mounted, fitted with two bronze stems, a bypass valve and a hydraulic operating cylinder, to work under the line pressure. Some idea of the care required in designing may be realized, when it is considered that the joint between the body and bonnet of the 36-inch valve was under a strain of about 3,000,000 pounds at test pressure. The shipping weight of the 36-inch valve was 18 tons.



LARGE 36-INCH GATE VALVE

New American Thompson Exposed Spring Indicator

With all the activity which has been stimulated in the indicator field during recent years, it is interesting to note the latest developments of the original Thompson indicator, made by the American Steam Gauge and Valve Manufacturing Company, Boston, Mass., which is shown in the accompanying illustration.

The spring is placed as near the cylinder as it is possible to get it, which is the main feature in the construction of this indicator, together with its short piston rod, which the spring surrounds,

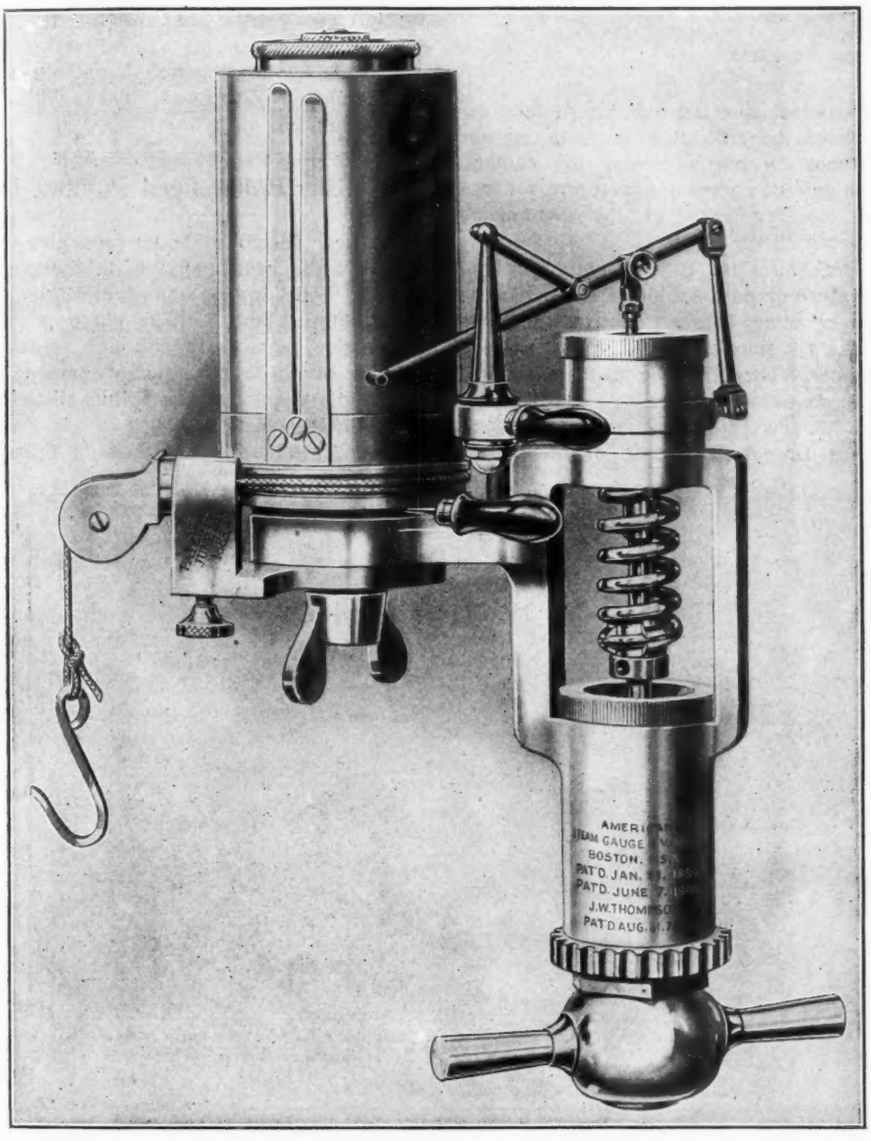
as the shorter the piston rod, the less liability there is of binding, and, therefore, the greater uniformity and accuracy of results.

The piston rod is only about ½ inch longer than the regular piston rod, and there is, therefore, only a slight increase in the weight of the piston and piston rod over that used in the inside-spring type. The chances for binding of piston are practically eliminated, and this design accomplishes all the accuracy originally gained with the short piston rod, with the advantage which all exposed and outside springs possess of being impervious to the effect of heat and cold, as the spring does not get hot enough to affect it at any time and can be readily changed without difficulty with bare hands. For instance, live steam entering the indicator cylinder at 120 pounds pressure would have a temperature of approximately 350 degrees. If the steam in the cylinder expands down to two pounds above atmospheric pressure, the temperature would be approximately 219 degrees, or a difference of 131 degrees, which could not occur with the outside spring under any working conditions.

This design eliminates the possibility of corrosion from the moisture in the indicator cylinder. It will be seen that the design of head supporting the pencil arm permits air to circulate around the spring.

The American Thompson types of indicator are so well known that it is sufficient to state that the pencil motion is the same as the regular design of three to one ratio.

The instrument is equipped with the new improved return motion, and in order to stop the paper drum when the indicator is equipped with this device the lever, shown between the drum and frame, is moved in the direction of travel by the paper drum until the drum releases itself. The lever is then returned to its original position. When about to take a diagram the paper drum is turned forward by means of the nurled rim at the top until it catches, causing the drum to revolve in the usual way.



NEW AMERICAN EXPOSED SPRING INDICATOR

"Hydro" Recording Velocity Gage

This instrument is for the purpose of measuring the velocity of the combustion gases, also their volume, and recording the same on a chart, placed on a recording drum. This serves as a guide to the fireman, as to what method of firing and draft manipulation will produce the best results.

Fig. 1 shows the construction of the apparatus, which consists of a cylindrical vessel *G*, a cover *A*, which dips with its outer rim into a liquid contained within the annular space between the vessel *G* and cylinder *H*. This liquid acts as a seal for the gas within the vessel *G*. The working parts of the instrument consist of the bell *B*, to which is attached a float *C* guided upon a rod *D* and submerged in the operating fluid. Gas pressure is introduced under the bell through the nozzle *T* and above it through the nozzle *U*, the difference, causing the movements of the bell which are carried outwardly to the recording drum containing the clock work of the instrument by means of the rod *E* working through a tube *F* attached to the cover *A*.

The construction is such that a differential pressure of 1 inch of water represents a movement of 4 inches of the bell, and this being obtained without the

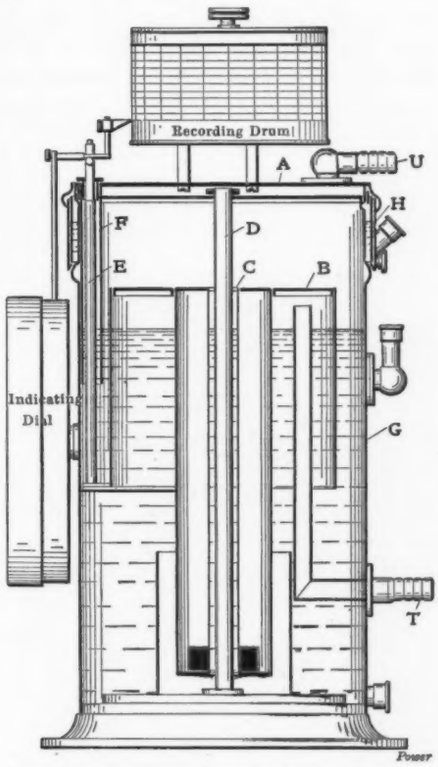


FIG. 1. SHOWING DETAILS OF RECORDING GAGE

use of magnifying levers indicates extreme sensitiveness and accuracy of indications for the instrument. In order to make the indications plainly visible the instrument indicates, by an increase of the differential pressure and the curve points upward.

On the chart, the curves properly point

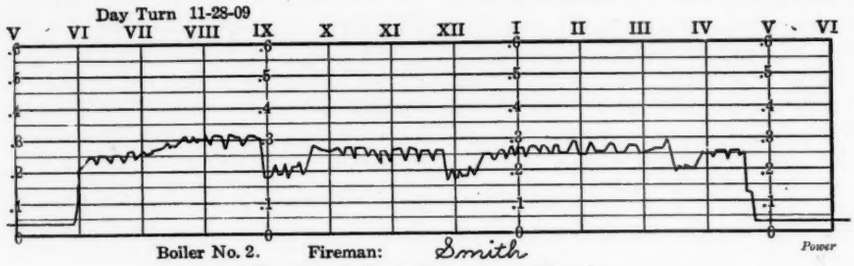


FIG. 3. A REPRESENTATIVE CHART

to the fireman the rod *E* is further connected to a dial indicator magnifying the actual differential pressure forty times, Fig. 2. Fig. 3 shows how the instrument can be used as a check on the method employed by the firemen. The chart shows that the fireman began getting up steam at 6 a.m., the damper being closed during the night and the differential pressure being 0.025 inch. At 6 a.m. he opened the damper, the differential pressure increasing at once. After that the differential pressure gradually increased and the chart shows in nearly regular intervals downward pointed curves, which occur when the fire door is opened and fresh fuel added.

The curve would point upward if the damper is not closed simultaneously with

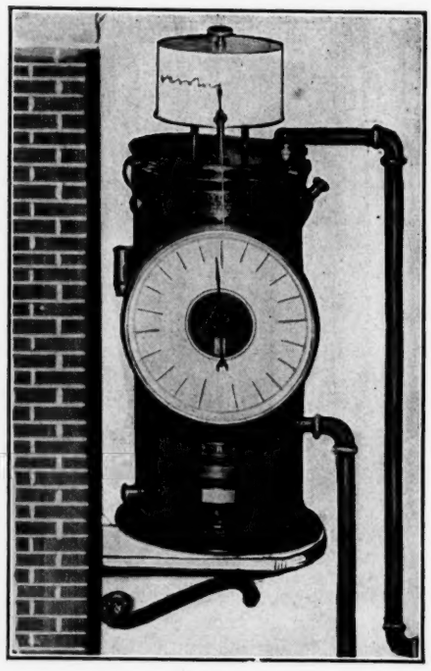


FIG. 2. SHOWING RECORDING DRUM AND GAGE

the opening of the fire door, as the opening of the fire door permits the air to enter direct, eliminating the resistance of the grate against the passage of the air, and thereby permitting a greater amount of air to enter the flues. This, downward, showing that the fireman decreased the amount of air entering the furnace by partly closing his damper. The pointed curves are therefore, a check on the regularity of the combustion process.

Between 9 and 10 a.m., the differential pressure drops for a long time, indicating the cleaning of the fire from clinkers with a simultaneous greatly closed damper. Thereafter the combustion process continues regularly as indicated by the downward-pointed curves and at about 12 p.m., the drop of the differential pressure indicates a second deposit of clinkers.

Between 1:30 and 3 p.m., the points of the curves are less sharp, indicating that the fire door remained open longer than previously. Between 3 and 4 p.m., the chart indicates another deposit of clinkers. At 4:30, half an hour before closing down, the differential pressure drops again to 0.025 indicating that the fireman has banked his fire for the night.

It is evident from the foregoing that the work of the fireman can be checked during his watch; the instrument is equally useful for mechanical stokers. It is made by the "Hydro" Manufacturing Company, 720 Lewis block, Pittsburg, Penn.

Heisler Boiler Feed Pump

The new design of boiler-feed pump, shown in the accompanying illustration, is made both duplex and duplex compound, Figs. 1 and 2. The pump is of the outside-packed, direct-acting, semi-pot type, with sealed plunger packing, and all joints tongued, Fig. 3, thus eliminating all flat gaskets.

The adjustable stuffing box is fitted

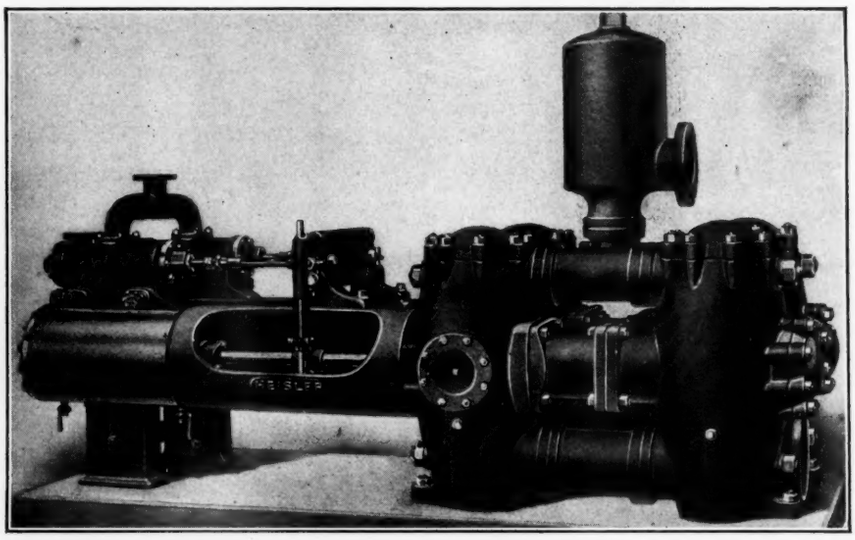


FIG. 1. DUPLEX HEISLER BOILER FEED PUMP

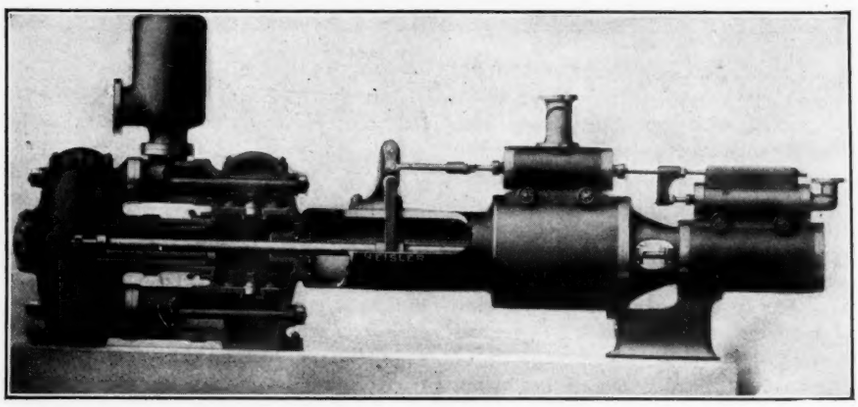


FIG. 2. SEMI-SECTIONAL VIEW OF WATER END

with a seal to prevent air from leaking into the pulsating chambers, thus eliminating destructive water hammer, it is claimed.

By referring to Fig. 2 it will be seen that long rods are used to hold the water end of the pump together instead of a large number of short flange bolts, the

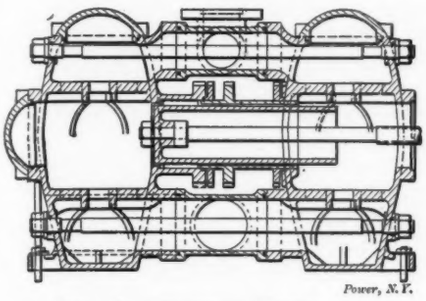


FIG. 3. TONGUED JOINTS

idea being to prevent any tensile stress or shock from coming upon the castings connecting the two water chambers. The construction permits of dismantling the entire water end by the removal of only four nuts. These pumps have never yet shown a leak or defective bolt after once being assembled, even when operated under abnormal conditions, it is claimed by manufacturers.

It is also claimed that owing to the pump having a minimum of plunger friction, smaller steam cylinders are used, and that the cost of plunger packing is greatly reduced.

The anticramping plunger sleeve is adjustable endwise, one end entering the main stuffing box and the other end passing through an auxiliary stuffing box, which makes a watertight telescopic joint between the plunger chamber. This sleeve prevents all possibility of cramping the plunger. A suitable seal is arranged near where the plunger sleeve enters the main stuffing box end of the plunger sleeve or through the main stuffing box to the exterior of the pump, and also to prevent air from entering the plunger chambers while passing along the same route. The plunger and delivery chambers are spheroidal and have deep internal ribs to strengthen them.

These pumps are manufactured by The Heisler Company, St. Marys, Ohio.

Pop Safety Valves for House Heating Boilers

The Lonergan "H H" valve was designed to supply house-heating boilers with a valve that was "fool proof" and of suitable design.

It is made with the hexagon base so heavy that it cannot be crushed even if the Stillson wrench is used, it is claimed.

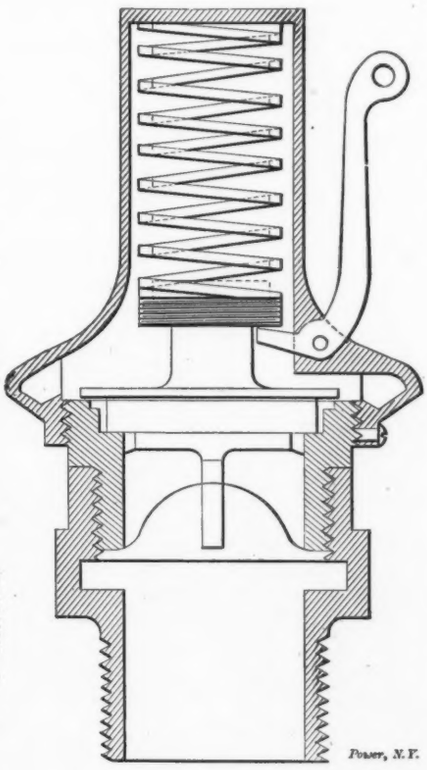


FIG. 1

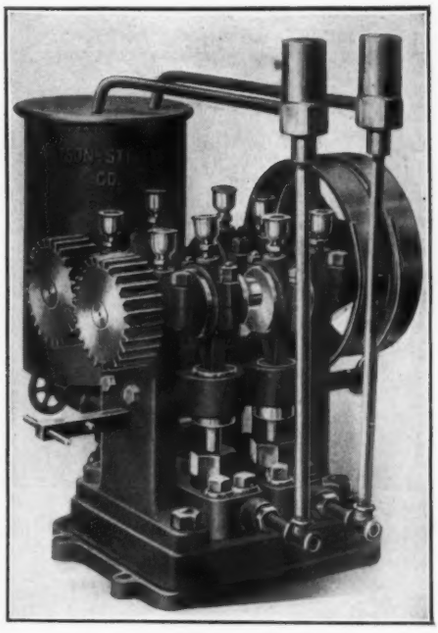
There is no adjusting screw, lock-nut or cap to get out of order, the resetting of the valve being performed by screwing the top casting onto the base casting until the holes drilled and threaded in both come opposite one another, so that the screw provided for this purpose can be put in place, and as there is only one relative position to the top and base where this can be done the valve is necessarily reset at the same popping point at which it was set originally, Fig. 1. This feature often does away with a great deal of trouble and annoyance, as for instance if the valve leaks through sediment of some kind lodging on its seat, it can be easily taken apart, the sediment removed and reassembled by an attendant without any trouble.

It is equipped with an extra long spring and of large diameter, thus giving a very large lift to the valve when in operation.

These valves can be furnished with either up blow, down blow or side blow in the same design as shown in Figs. 2, 3 and 4, and are manufactured by the J. E. Lonergan Company, 211-215 Race street, Philadelphia, Penn.

A Small But Powerful Hydraulic Pump

The four-cylinder, two-pressure line hydraulic pump illustrated herewith, represents a new type of pump by means of which one-, two-, three- or four-pressure lines may be served independently of each other, but from a common reser-



SMALL HYDRAULIC PUMP

voir. Each pressure line has a separate pressure chamber, safety valve and release line and is served by a separate pair of cylinders, of ½-inch diameter by ½-inch stroke, having eccentrics set to give a continuous flow. Any pres-

FIG. 2

FIG. 3

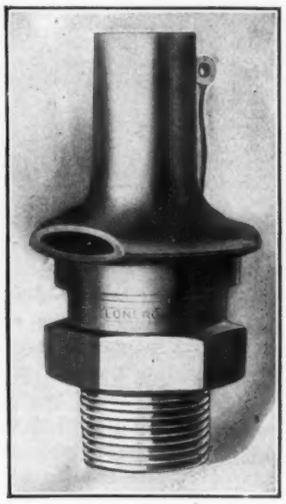


FIG. 4

sure up to 600 pounds per square inch may be delivered into any line, the limit in each instance being determined by the setting of the safety valve, which opens as the pressure tends to exceed the limit and lets the surplus liquid pass through the release pipe to the reservoir. Any pressure line can be thrown entirely out of service by opening the safety valve, in which instance all the liquid in that line pumps directly back to the reservoir.

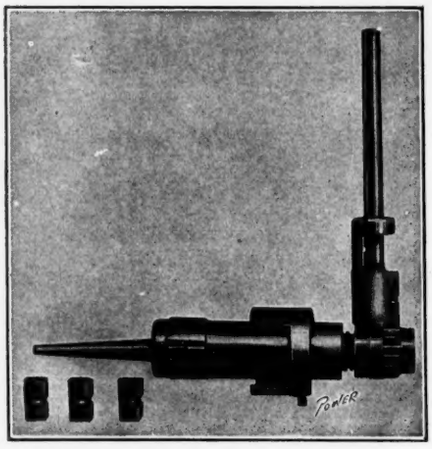
The one-, two-, three- and four-pressure line pumps are practically the same in design, save for change in the length of the bedplate and the shafts to accommodate the required number of pressure chambers, cylinders, piston rods, eccentrics, etc., and may be fitted with an electric motor instead of the pulley shaft shown. These pumps are made by the Watson-Stillman Company, 50 Church street, New York City.

Combination Tube Expander and Cutter

The tool is so designed that the body and mandrel work together with one piece when secured by a locking device.

This tool performs the office of two distinct tools. It will cut off a set of tubes just inside the tube sheet, trim them to the proper length on the outside for beading, and can be changed in two minutes' time to a tube expander to roll the tubes.

The wearing parts are made of the best tool steel. The rolls are made tapering



TUBE EXPANDER AND CUTTER

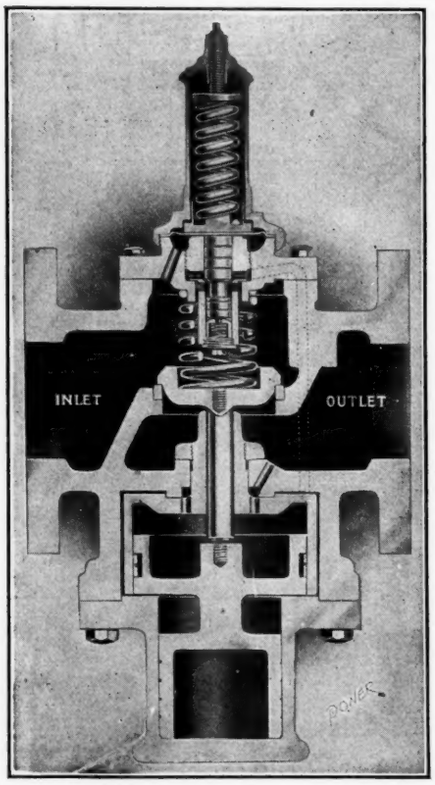
so as to conform to the taper of the mandrel, so that the pressure is even across the entire thickness of the flue sheet, which gives the bearing the full thickness of the sheet instead of one edge. The cutters are inserted from the inside the same as the rolls, and will not drop out, being secured in place. They are made in sizes from 1½-inch up to and including 4-inch.

An extension wrench is also made for operating the expander and cutter in the smoke box or return tubular boiler where the operator cannot well get in the box and it becomes necessary to do the work from the outside. The expander can be worked from a standing position. The one set of handles works the screw feed, the other does the cutting or rolling. Either work independent of the other. It is quickly attached by simply removing the ratchet. The expander can be worked with chuck or air force by removnig the ratchet and using the chuck. This attachment is made for all sizes. A drill attachment is also made.

This tool is made by the Mansfield Machinery and Supply Company, Mansfield, Ohio.

Mason Excess Pressure Pass-over Valve

This valve, which is a modification of the Mason standard reducing valve, is intended for use in systems where boil-



MASON EXCESS PRESSURE PASS-OVER VALVE

ers operating under different pressures are used, allowing the excess of steam generated in one battery to pass to the one operating under a lower pressure.

In the standard reducing valve the operation is controlled by the pressure on the outlet side, while in the excess-pressure valve the operation is regulated by the pressure on the inlet side. Referring to the illustration, in the upper part of the valve will be seen a diaphragm, to which is attached a balanced piston valve controlling the opening to a passage, shown in dotted lines, leading to the under side of a large spring-ring packed piston directly under the main steam passage. From the inlet side of the valve there is a short port or passage leading directly to the under side of the diaphragm.

When the pressure on the under side of the diaphragm exceeds that of the spring above it, the piston valve opens, letting direct pressure to the under side of the piston which, being larger than the main valve, rises and allows steam to flow from the inlet to the outlet side of the valve.

It will also be noticed that a passage leads from the outlet side of the valve body to the upper side of the piston, subjecting it at all times to the pressure of the steam on the outlet side. This pressure, operating in conjunction with the pressure of the adjustable spring above the diaphragm, determines the pressure at which the valve will open and allow steam to flow from the higher pressure line to the lower.

The auxiliary valve is held in contact with the diaphragm by a small helical spring and easily moves up and down with it. When the auxiliary valve opens, steam passes up around the chamber, through holes under the seat, and out to another set of holes, which connect with a passage leading to the space around the lining, and thence under the piston. By the raising of the piston the main valve is opened against the initial pressure.

This valve is manufactured by the Mason Regulator Company, Boston, Mass.

In setting a valve, especially on a large engine, the fact must not be lost sight of that the expansion of the different parts of the engine will alter the adjustment. The indicator should always be used to check the accuracy of the result. In setting the valve on a vertical engine, do not forget that the weight of the valve will take up the lost motion in only one direction, whereas, when the engine is running, the friction due to the pressure of steam holds the valve up and the eccentric pulls it down. It is better to attach a tackle to the top of the valve and set it up enough to take up the lost motion, in getting the lead at the top for a slide valve. On a piston valve, this is not necessary as the valve always tends to go downward.

To find the diameter of a large flange on a horizontal line of pipe, tie weights to the ends of a string and throw it over the flange, allowing the ends to hang down. Then measure the distance between the vertical legs of the string.

NEW PUBLICATIONS

INTERNAL COMBUSTION ENGINES. By William M. Hogle. Published by McGraw-Hill Book Company, New York, 1909. Cloth; 256 pages, 5½x8½ inches; 106 illustrations. Price, $3.

This is one of the most haphazard, unsystematic compilations of information and platitudes that has come to the reviewer's notice in years. According to the subtitle, it is a "reference book for designers, operators, engineers and students," and the preface informs us that it has been placed on the market principally because there is a "lack of satisfactory compact reference books" on the subject! The other books are excellent academically but "fall far short in the matter of present practice and modern design." Inferentially, Mr. Hogle has undertaken to fill the gap. The merit of the book as an exponent of "present practice and modern design" is beautifully illustrated by the chapter on general dimensions, occupying not quite five pages, and those on valves and valve mechanism, which are restricted to simple cam motions and the Winton automobile valve gear. There is no discussion or attempted exposition of double-acting engine construction, the knowledge of the "author" evidently being limited to small single-acting engines. The most useful feature of the book is a table of logarithms in the back.

THE STEAM ENGINE. By Charles H. Benjamin, M. E., D. Eng. Published by The Technical Press, Brattleboro, Vt. 416 pages; 6x9 inches; illustrated; cloth. Price, $3.

Doctor Benjamin is the dean of the schools of engineering of Purdue University, and his book is written from the standpoint of the instructor rather than that of the practioner; that is, as a student's textbook rather than as an engineer's book of reference. The Elementary Principles are expounded by the use of the calculus, but the succeeding chapter is so simple as to be based upon an outline drawing of a simple steam engine with all the parts described by numbers as 1, steampipe; 17, flywheel, etc. The third chapter is devoted to The Thermodynamics of Air, and again requires a mathematical equipment including the calculus for its reading. Isothermal and adiabatic expansion, and the Carnot cycle are explained, leading to considerations of the air compressor, the hot-air engine, and then to the gas engine which the author characterizes as "a hot-air engine in which the air is heated by the explosion of gas inside the cylinder of the engine itself." Otto and Diesel cycles with entropy diagrams for each are shown.

In Chapter IV, The Thermodynamics of Steam and of the refrigerating machine are simply and logically explained by means of the entropy diagram.

The consideration of the mechanism as distinct from the medium commences with a chapter upon Valve and Link Motions, the Zeuner diagram being used throughout in the demonstrations.

Indicators and indicator diagrams are disposed of in ten pages. Compound Engines are then considered, a modification of Professor's Ripper's volume chart being used. The chapter upon Governors explains the principles involved in the simple and weighted pendulum; shaft governors of the centrifugal and inertia types, the Corliss, Joy, Allen and other special applications. The chapter upon Flywheels treats not only the equalization of rotary movement but the principles involved in counterbalancing. In the chapter upon Steam in the Cylinder, which deals with the varying amounts of steam through the stroke due to condensation and reëvaporation, the author steps aside to describe a number of superheating devices. Condensers and Heaters are taken care of in twenty pages, discussing principles rather than recent developments in the apparatus. The chapter upon Piping and Flow of Steam discusses the energy available to induce flow by drop of pressure and the Napier formula for flow through orifices. For the flow of steam in long pipes the formula made familiar by its publication in successive issues of "Steam" is considered with the modifications pointed out by the work of Professor Carpenter. The chapter also treats as collateral subjects, condensation in piping, pipe coverings, calorimetry steam separators and sight-feed lubricators.

The chapter upon Engine Performance commences with an exposition of the Willans law and the modification of the Willans straight line by variable expansion. Performance curves are given for various types of engine. Stanwood's tables of computed and actual consumptions are reproduced from the Mechanical Engineers' Proceedings, and other performances from French's work on the steam turbine quoted. A chapter upon Engine Design treats those particular features which require consideration further than that involved in ordinary machine design.

The final chapter deals with Specifications and Costs and contains besides a specimen specification of a pumping engine, tables and diagrams embodying collected data by the professor and his students of the cost of engines of various types reduced to a horsepower basis. The usual "useful tables" are appended, those of the physical properties of steam being abridgments of the older tables uncorrected for the recent more precise determinations of the values of the total heats.

WESTINGHOUSE DIARY FOR 1910. Published by the Westinghouse Electric and Manufacturing Company, Pittsburg, Penn., for complimentary distribution.

This year's edition of the little vest-pocket diary is particularly attractive. Besides the diary for the new year there are about 100 pages of engineering data on electrical machinery, circuits, lamps and storage batteries; steam turbines, condensers, gas engines, Roney stokers, Morse chains, block signals and rail-joints. The quantity of information presented in a book 2½x5½ inches in area and ¼ inch thick is astonishing. These diaries are not for sale; they are sent to a limited number of engineers and users of machinery.

OBITUARY

Dr. Ludwig Mond

Dr. Ludwig Mond, the distinguished chemist, inventor, technologist and art connoisseur, died on December 10 at his London residence. Doctor Mond was born at Cassel, Germany, March 7, 1839; and was educated at the Polytechnic School, Cassel, and at the universities of Marburg and Heidelberg. In 1862, he went to England and engaged in the Leblanc soda industry, introducing his process for recovering sulphur from alkali waste. In 1873, he established, in partnership with T. T. Brunner, at Winnington, Northwich, Cheshire, the manufacture of ammonia-soda by the Solvay process, which he perfected; and the works there constitute the largest alkali establishment in the world.

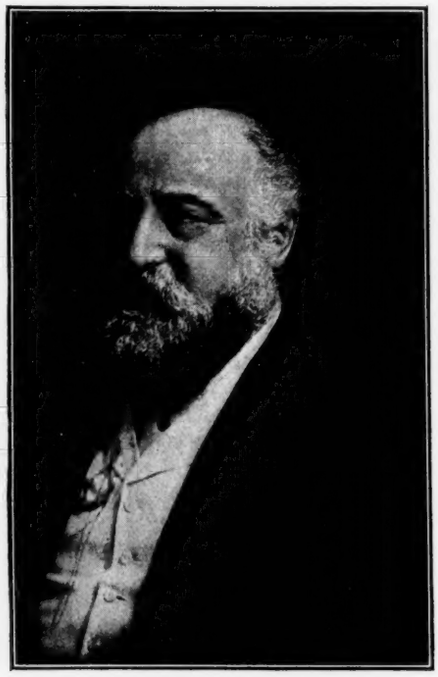
In 1879 he began investigation of the problem of obtaining ammonia from the nitrogen of the air, and this work led to the design of the celebrated Mond gas producer with byproduct recovery. The first application of this system was made at the works of Brunner, Mond & Co., mentioned above, and included provision for recovering sulphate of ammonia as a byproduct. Although the presence of nitrogen and ammonia in the producer gases had been generally known for many years, it remained for Doctor Mond to discover that the quantity of ammonia depended to a considerable extent upon the temperature conditions during gasification, and that by using coals having a high-nitrogen content it was possible to recover sufficient sulphate of ammonia to pay a very large proportion of the expense of operating the plant. Doctor Mond also discovered that it was possible to pass sufficient steam through the producer to quench the fire theoretically without quenching it actually, and by this means to keep the zone of ammonia production at the relatively low temperature required for a high rate of recovery. Theoretically if the weight of steam

equals the weight of coal, the fire will be extinguished; in the Mond producer the weight of steam passed through per hour is about 2½ times the weight of coal fed to the generator.

While it is due to his classic work on the gas producer that Doctor Mond is so well known in the field of power-plant engineering, this was really a minor phase of his activity. His principal work was along chemical and metallurgical lines, in both of which fields he was a master.

Doctor Mond was an art lover, and his collection of early Italian masters is one of the finest in England. He was fond of Italy, and maintained a residence at 64 Via Sistina, Rome.

He founded and endowed the Davy-Faraday Research Laboratory of the Royal Institution in 1896. He was a fellow of the Royal Society; vice-president



DR. LUDWIG MOND

of the Royal Institution; a life member of the London Chemical Society, of which organization he served on the council in 1885-6, and acted as vice-president in 1887-90, and 1894-98; an original member of the Society of Chemical Industry, of which he was president in 1888-89 and vice-president in 1890; a member of the British Association for the Advancement of Science, acting president of the Chemical Section in 1896; an honorary member of the Deusche Chemische Gesellschaft since 1908; and a member of the Berliner Verein Deutscher Chemiker. He was also a fellow of the Institute of Chemistry, and the recipient of the honorary D.Sc. degree from Victoria and Oxford universities, and an honorary Ph.D. from Heidelberg University. He was vice-president of the joint organizing committee of the Seventh International Congress of Applied Chemistry, which was held in London from May 27 till June 2, 1909; and acted as president of Section II, Inorganic Chemistry and Allied Industries. During the session of the congress, Doctor Mond held several receptions at his home. The guests at one of these included the entire Italian delegation which took advantage of the occasion to present Doctor Mond with a noble bronze in appreciation of his numerous gifts to the art and science of Rome.

John A. Shultz

John A. J. Shultz, president of the Shultz Belting Company, died at his home on Washington avenue, St. Louis, Mo., on December 24, 1909. His death was the result of embolism, induced by spraining an ankle. Mr. Shultz was one of the foremost business men of St. Louis. He was born in Grantsville, Md., on April 27, 1837. He entered business life in his father's tannery, the possession of which he secured upon his father's death. In 1864 he moved to St. Louis and soon thereafter entered the hide and commission business under the firm name of Shultz & Samples. Shortly after this he went into the tannery business under the firm name of Ford & Shultz. About this time he made the acquaintance of General U. S. Grant. The General's brother, Orville Grant, was engaged as a salesman for the tannery. Upon the death of Mr. Ford in 1876, the Shultz Belting Company was organized. Since that time Mr. Shultz has devoted all his efforts to perfecting his product. Only a few weeks before his death, he was reëlected president of the Missouri Manufacturers' Association. Mr. Shultz is survived by four daughters and two sons. One of the latter, John R. Shultz, is vice-president and an active factor in the affairs of the company.

John H. Lidgerwood

John H. Lidgerwood, vice-president and treasurer of the Lidgerwood Manufacturing Company, died in his eightieth year on January 1, at his home in Morristown, N. J. Although he had been confined to the house for several months by neuritis, his death was entirely unexpected.

Mr. Lidgerwood was born in New York City. When he was 16 years old, his family removed to Morristown, which has been his home ever since. His mother, then a widow, married Judge Stephen Vail, proprietor of the Speedwell Works of Morristown. The Speedwell Works were among the most important of the earlier forge and machine shops. In them were built the engines for the "Savanah," the first steamship to cross the ocean. It was in these works, also that Morse, assisted by Alfred Vail, constructed his first electric telegraph.

Upon the retirement of Judge Vail, the management of the works was taken by his son George Vail, who later was succeeded by Mr. Ligderwood.

In 1873 the Lidgerwood Manufacturing Company was formed. It took over the business of Lighthall & Beekman who had started the manufacture of a rotary engine and hoisting engines in Brooklyn near the site at present occupied by the company's main works.

The hoisting-engine business grew rapidly, beginning with a demand for pile-driving engines, then extending to engines for freight handling and finally to engines for service in every field where heavy weights are lifted or quantities of material are handled. The Speedwell Works developed the special business of manufacturing coffee and sugar machinery.

For the better handling of the latter business, W. V. V. Lidgerwood, president of the company, removed his headquarters to London. This left John H. Lidgerwood in immediate control of the business of the Lidgerwood Manufacturing Company and the development of its operations to the present proportions.

Mr. Lidgerwood is survived by his wife, two sons and four daughters.

Joint Meeting of Mechanical Engineers

In response to the invitation of the Institution of Mechanical Engineers of Great Britain, received and accepted by the American Society of Mechanical Engineers, and recently sent out to the general membership, 133 members and 100 ladies have signified their intention of attending the joint meeting in Great Britain in the summer of 1910, and 183 have expressed themselves as giving the matter favorable consideration.

The present indications are that some of the functions will be held in Manchester, Birmingham or Sheffield, possibly concluding in London, and the invitation itself is an earnest of the notable professional and social opportunities which will be extended to the American society. Arrangements will probably be made for the accommodation of the members on the same steamer.

Where time and personal engagements permit, the visiting members will have the opportunity of attending the following events and meetings which are to take place during the summer of 1910: Anglo-Japanese Exhibition at Sheperds Bush, London; American Exposition in Berlin; Brussels Universal and International Exhibition; London Pageant, probably at Chester; Pageant at Bristol; Church Pageant at Fulham Palace;

Military Pageant in London; International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, at Düsseldorf; International Sports Exhibition at Vienna; International Exhibition of Arts and Industries, Alexandra Palace, London; the Passion Play at Oberammergau.

It is expected that papers will be presented by members of both societies on electrification of railways, on roundhouse practice and the handling of locomotives at terminals, on certain phases of machine-shop practice, and on the subject of standards for gear teeth which is now being considered by a committee of the American society as well as by a committee of the Institution of Mechanical Engineers. While papers will be mainly restricted to the subjects indicated, the meetings committee will be pleased to consider papers on other subjects.

Society Notes

The spring meeting of the American Society of Mechanical Engineers will be held this year as usual, in addition to the London meeting which occurs in July. Atlantic City has been selected by the meetings committee and approved by the council as the place and the time will be from May 31 to June 6, inclusive. The headquarters during the meeting will be at the Marlborough-Blenheim hotel.

The senior mechanical engineers of the university of Wisconsin have recently organized a student section under the rules set down by the American Society of Mechanical Engineers. The section had its first regular meeting Thursday, January 13, when it was addressed by Dean Gross of Purdue University. The section enjoys a membership of 38 students besides several honorary members of the American Society of Mechanical Engineers.

The Educational Committee of Kentucky No. 1, N. A. S. E., of Louisville, has arranged an interesting winter series of lectures, which began January 4 and will be held weekly up to April 26. The subjects chosen are as follows: Problems in Direct-current Wiring, by A. M. Cowherd, January 18; Lubricating Oils, by C. C. Stoll, January 25; Leather Belting, by Edward Kochenrath, February 1; Installing Shafting, by J. D. Gregory, February 8, and a number of other practical subjects up to the date mentioned.

On Wednesday evening, January 5, F. McNeill lectured before Illinois No. 1, N. A. S. E., on Motor and Generator Testing. Mr. McNeill spoke from an experience of several years in the testing department of a large manufacturing concern, and brought out in a simple way, many points regarding the testing of electrical machinery by the purchaser, before being accepted. The talk was illustrated by lantern slides showing various methods, connections, etc., used in the work. It was an open meeting and there was a large attendance.

The Blue Club Engineering Society of Greater New York held its annual smoker on Thursday evening, January 6, at its meeting rooms, in the Engineering building, West Thirty-ninth street, New York City. A representative gathering of members and friends were in attendance, and a pleasant evening was passed. An entertainment of merit was given by the "Bunch." Refreshments of all kinds were served. The officers of the club are F. E. Styles, president; C. K. Van Etten, vice-president; J. J. Chisholm, treasurer; W. D. Sprague, secretary.

The National Association of Stationary Engineers, San Francisco No. 1, held an informal smoker and house warming on Thursday evening, December 30, in their new hall at 172 Golden Gate avenue. The president of the association addressed the assemblage and extended a cordial welcome to all. Many of the officers and members of California No. 3 were present. Following a number of jovial songs and stories, speeches were made by Past-president J. W. Maher; W. N. Munroe, president of No. 3; David Thomas, J. B. Warner, J. L. Davis, B. E. George and many others. Notwithstanding the inclement weather, it was in the wee small hours of the morning before the guests repaired to their respective homes. There were present about 160 visitors and members.

Personal

After twenty years spent in the machinery and mill-supply business, E. W. Puckett has become connected with the Trade Mark Title Company, a corporation organized for the purpose of designing, registering and protecting trade marks.

In putting an extra boiler into a battery there is sometimes a rush of water which has lodged in a pocket in the pipe, and which comes over into the main steam pipe as soon as the stop valve is opened. To obviate this, open the stop valve slowly when the steam is five pounds short of the pressure in the main line. The steam will then flow into this boiler and push the water with it. If there is a condenser attached to engine, be sure that all the air is out of the boiler before opening the stop valve or the vacuum is liable to drop rapidly owing to the rush of air being greater than the air pump can handle.

Engineering Societies

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building; 29 West 39th St., New York. Monthly meetings in New York City. Spring meeeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association headquarters, 29 West Thirty-ninth St., New York.

ENGINEERS' CLUB OF PHILADELPHIA

Pres., William Easby, Jr.; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATION.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, Washington, D. C., January 17-21, 1910.

Business Items

The Dearborn Drug and Chemical Works have sent out as usual a large wall calendar for the new year.

The American District Steam Company, Lockport, N. Y., has sent us a very beautiful wall calendar for 1910.

The name of the firm of Charles L. Stevens & Co., Detroit, Mich., has been changed to the F. L. Sutherland Company. They make leather valves and the "long-life" leather packings.

The York Manufacturing Company, York, Penn., manufacturers of ice-making and refrigerating machinery have sent us a list of 46 recent sales aggregating 2478 tons of refrigeration.

N. S. Burnham, who has been for some time connected with the circulation department of POWER, has accepted a position with the McLeod & Henry Company, manufacturers of "steel mixture" furnace linings and will be connected with the New York City office representing the company in Greater New York and vicinity.

The Northern Equipment Company, of Chicago, which recently absorbed the American Boiler Economy Company, report that on account of the rapid increase in the sales of the Copes boiler feed regulator and the Copes pump governor, they have been compelled to move to a larger factory building. They have also given up the office in the Old Colony building, and the factory and main office is now located at 408-418 West Indiana street, Chicago, Ill.

Pursuing the custom established three years ago, the American Blower Company this Christmas presented each employee with a sum in crisp new dollar bills, equal to the years of their continued service with the company. Along with the money was given an illustrated booklet, containing a short historical sketch of the institution, of which the employees form such an important part, and all inclosed in an envelop decorated in holiday colors.

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, has received a letter from B. F. Spooner, president of the Lake Arthur Light and Water Works, Lake Arthur, La., in which he says: "Some time ago we wrote you that we would report later on the performance of the floating skimmers we purchased of you. We will now say it is doing well. After about three months' steady use, we examined the boilers, and found no cleaning whatever necessary."

A new organization, known as Green, Hook & Co., has been incorporated to manufacture and compound chemicals for boiler treatment. The executive end of the business will be largely in the hands of Stanley K. Green, who has been connected with the George W. Lord Company and the Bird-Archer Company. The main offices of the company are located in the Hudson Terminal building, New York, with branches in Boston, Philadelphia, Baltimore, Norfolk and Havana.

The Watson-Stillman Company has made several additions to its sales department to handle the increasing business in hydraulic tools and turbine pumps. Edwin Stillman has entered the sales department and is assisting in taking care of customers in New York State, while all southern railroad business is now in charge of Frank C. Clark. The more direct representation that has become necessary in the Orient will be in the hands of F. W. Horn, the well-known machinery importers, of Yokohama, Japan.

The Bayer Soot Blower System, of St. Louis, reports brisk business in its blowers for water-tube boilers. One of the more recent installations was placed through the Pittsburg office at the plant of J. L. Stifel & Sons, Wheeling, W. Va., where the Bayer system is taking care of four 300-hosepower Geary water-tube boilers. The Bayer company say that engineers, who have seen this system in operation, have pronounced it a necessary adjunct to a water-tube boiler, and it is not surprising that the factory is behind on its orders.

The Bruce-Macbeth Engine Company, of Cleveland, builders of two- and four-cylinder vertical gas engines, have opened a branch office in Philadelphia at 1020 Drexel building. This office will be in charge of M. E. Jackson, who will be prepared to furnish complete information relative to gas engines, producers and complete gas-power plants. This territory offers a particularly attractive field for gas-power installations on account of the high cost of steam and central station power, and the Bruce-Macbeth Engine Company found it necessary to open this branch office to handle its rapidly increasing business.

New Equipment

The Frontier Ice Company, Buffalo, N. Y., will build a new factory.

The Darlington (S. C.) Water and Electric Company will build a new plant.

The Connecticut Company, Bridgeport, Conn., will enlarge its main power station.

The Manhattan Oil Company will build a new boiler house at Omaha, Neb.

The Shurtleff Company will erect a cold-storage plant at Janesville, Wis., to cost $10,000.

The Greeley (Colo.) Street Railway Company is having plans drawn for a turbine power plant.

The Fairmont Creamery Company, Omaha, Neb., will build a two-story addition for cold-storage purposes.

The H. J. Heinz Company is erecting a new power house at bottle department in Sharpsburg, Penn.

The Pittsburg & Lake Erie Railroad will enlarge its power station in Pittsburg. Steam turbine will be installed.

The Sylvan Cotton Mill Company, Shelbyville, Tenn., will install new water wheels and make other improvements.

Spang, Chalfant & Co., Sharpsburg, Penn., is preparing to erect a new power house and electrical-equipment building..

Techow & Loucks, Panuco, Dgo., Mexico, will install a new or second-hand gas engine to operate a mine hoist.

The Willimantic (Conn.) Gas and Electric Light Company will install turbine engines in its plant in the near future.

The Vincennes (Ind.) Water Supply Company will install a new boiler plant, pumps and Corliss air compressor the coming spring.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids January 25 for two triplex power pumps as per Schedule No. 2125.

It is reported the Bluffton, Geneva & Celina Traction Company, Bluffton, Ind., will build a new engine or steam-turbine power plant in the near future.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids January 25 for eight marine water-tube boilers as per Schedule 2116.

J. F. Boyd, operating electric-light and milling plant at Shelbyville, Tenn., will install a new water wheel and make extensive improvements to his plant in the spring.

The Navy Department, Bureau of Supplies and Accounts, will open bids January 18 for centrifugal pump and motor as per Schedule 2081 and vertical triplex pump as per Schedule 2065.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Technical graduate to act as superintendent's assistant, in large gas plant; excellent opportunity to learn gas manufacture. Address "A. B. C.," Box 106, POWER.

AGENTS WANTED—23 FOR DIRT cleans everything; every engineer needs it. Send 10c. for can; agents wanted everywhere. Corliss Chem. Co., 403 S. 12th St., St. Louis, Mo.

AN ERECTING ENGINEER of experience capable of setting engines, installing boilers, repairing pumps, raising stacks, etc.; we want a good all-round man, one of initiative. Write the Globe Machinery and Supply Co., Des Moines, Iowa.

THE GAS ENGINE is the power of the future. Wanted: A sales manager experienced in this line with some capital to join us in pushing the sale of gas producers and engines; we have the factory and equipment; large business in sight; this is a fine opportunity. Address Box 101, POWER.

AGENTS WANTED—Agents to represent us in the sale of Cassco bar and ring metallic packing, a metallic packing which costs about the same as soft packing and will wear from seven to ten years; can be handled as a side line very acceptably; some territory still open for steam specialty men to handle the Erwood positive duplex blow off valve and the Erwood reversible automatic non-return valve. Address Triumph Engineering & Supply Co., 253 La Salle St., Chicago, Ill.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

MANAGER, sales manager, district manager, electrical or mechanical lines; 20 years' experience. Harwood, 20 Howard Place, Jersey City.

SITUATION WANTED by stationary engineer; seven years' experience with Corliss engines and generators, motors, pipe fittings, etc. Box 105, POWER.

POSITION WANTED by technical graduate, expert in combustion, furnace design and value of different coals. F. J. C., POWER, 355 Dearborn St., Chicago.

ENGINEER DESIRES change soon; sixteen years' experience in power plants, both a.c. and d.c.; three years on Curtis turbines, erecting and operating; best of references; location preferred, West or South. Box 104, POWER.

SITUATION WANTED by a gas engineer experienced on two and four cycle gas engines, also on suction and pressure producers and can furnish first-class references. Address "C. W. 86," care POWER.

WANTED—Position as engineer in a small electric light plant or assistant in a large plant in the West; have had three years' experience with boilers and engines, one year in central station; can furnish reference; 28 years old; strictly sober. F. W. Donahey, Gering, Neb.

CHIEF ENGINEER, experienced with compression in plants, turbines, Corliss and gas engines, desires to make a change to any kind of a plant; at present operating a central station containing two makes of turbines and compound condensing Corliss engines, a.c. and d.c. generators; 35 years old; strictly temperate and married. Box 106, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS secured. C. L. Parker, Solicitor of Patents, 4 McGill Bldg., Washington, D. C.

WANTED—One 150 horsepower Corliss engine in good condition. The Edgerton Electric Lighting System, Edgerton, Ohio.

ANY FIRM or engineer in charge of a steam plant that is troubled with scale in the boilers can get absolutely free, the best indicator and reducing wheel made, with velvet-lined mahogany case. For particulars, address Great Lakes Chemical Works, Manitowoc, Wis.

The annual meeting of the stockholders of the Hill Publishing Company, for the election